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SIGNAL TRAINING

VOLUME III

Pamphlet No. 26

SWITCHBOARDS U.C.
10-LINE and 6-LINE

1940

By Command of the Army Council,

THE WAR OFFICE,
22nd May, 1940

LONDON
Printed under the Authority of HIS MAJESTY'S STATIONERY OFFICE
by HARRISON & SONS, LTD., 44-47, ST. MARTIN'S LANE, LONDON, W.C.2.

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SIGNAL TRAINING, VOL. III

Pamphlet No. 26

SWITCHBOARDS, U.C. 10-LINE AND 6-LINE

1940

1. General description

1. *Purpose and facilities.*—The Switchboard U.C. 10-line shown in Plate I, and the Switchboard U.C. 6-line, shown in Plate XIII, are portable telephone switchboards for army use accommodating 10 lines and 6 lines respectively.

Apart from their use in locality offices, the 10-line switchboard is suitable for use in divisional signals and the 6-line switchboard for battalion and artillery regiments. The equipment has been designed for mobile operations and can be set up and dismantled easily and quickly.

The switchboards respond to and are provided with magneto generator and buzzer calling.

The 10-line switchboard is arranged so that telegraphy or telephony may be superposed on three lines, while the 6-line switchboard has facilities for superposing on one line only. The superposing is carried out by means of additional apparatus which may be attached to the switchboards.

Both switchboards are similar in construction and circuit details and are built on the unit principle, each comprising line units, common apparatus unit and operator's unit.

One line unit is used for each line and the assembly associated with any line may be removed for adjustment and repair without disturbing other line circuits. Lamps are provided on the line units for use as calling and clearing indicators.

The common apparatus unit includes a magneto generator and buzzer for calling purposes.

The operator's telephone circuit on both instruments incorporates an anti-side-tone circuit which suppresses side-tone to a low level.

The operator is protected from acoustic shock, due to key clicks or other forms of transient interference, by a "crash limiter."

A night alarm is provided, which may be used during quiet periods, so that when a subscriber on any line calls the exchange, a bell rings, in addition to the lighting of the indicator lamp of the particular line.

Under certain conditions of use the operator may be provided with a special microphone (Microphones, Respirator, No. 2) for use with a gas mask (Respirator Anti-gas Mk. V).

Superposing telegraphy or telephony, as already stated, may be applied to both switchboards. This is carried out by means of superposing units which may be readily attached and connected to the switchboards.

The Superposing Unit (Three Transformer) is normally used with the 10-line board for superposing on three lines (1, 2 and 3 of the switchboard). The Superposing Unit (One Transformer) is similarly used with the 6-line board for superposing on any one of the lines.

Both these units provide for series and phantom superposing.

The Superposing Unit (One Transformer) may be considered as a general purpose item, adaptable to any telephone switchboard when superposing is required.

2. *Weights and dimensions.*—Table I gives the approximate overall weights and dimensions of the Switchboard U.C. 10-line and the Switchboard U.C. 6-line, and of additional apparatus used in conjunction with these switchboards.

TABLE I

WEIGHTS AND DIMENSIONS

—— (1)	Weight. (2)	Length. (3)	Height. (4)	Depth. (5)
Switchboard U.C. 10-line, with night bell and battery, and Box, Accessory, for Switchboard U.C. 10-line containing 11 pulley weights and cords; operators' headphones and breast transmitter *or* Telephone, Hand, No. 2; and night bell connector	47 lb. 8 oz.	1 ft. 10½ in.	1 ft. 4⅛ in.	1 ft. 4¼ in.
Switchboard U.C. 6-line including battery and Box, Accessory for Switchboard U.C. 6-line, containing 7 pulley weights and cords; operator's Telephone, Hand, No. 2; night bell and connector	35 lb. 6 oz.	1 ft. 5½ in.	1 ft. 4⅛ in.	1 ft. 4¼ in.

TABLE I—*continued*

WEIGHTS AND DIMENSIONS—*continued*

—— (1)	Weight. (2)	Length. (3)	Height. (4)	Depth. (5)
Superposing Unit (Three Transformer)	15 lb. 4½ oz.	4⅛ in.	5⅞ in.	4⅝ in.
Superposing Unit (One Transformer)	3 lb. 8 oz.	5 in.	4⅛ in.	4½ in.
Boxes, Spare for Line Unit, containing one line unit	2 lb. 3 oz.	8⅛ in.	2⅞ in.	4¾ in.

3. *Range of working.*—The operator's telephone set included in the Switchboard U.C. (10-line or 6-line) has a performance equal to that of the Telephone Set D, Mk. V, or the Telephone Set F, Mk. I. The ranges given in Sec. 1 of the pamphlets dealing with these instruments will apply when working from one switchboard to another or from a switchboard to either telephone set.

The sensitivity to ringing currents of both switchboards is considerably greater than that of switchboards using drop indicators for magneto calling.

The range from the switchboard may vary considerably under different conditions and the figures given in Tables II and III for speech and buzzer calling are intended to serve as a guide only.

TABLE II

APPROXIMATE RANGES FROM SWITCHBOARDS U.C. FOR SPEECH WORKING

Type of line. (1)	Approximate range in miles. (2)
Laid on ground—	
D3 twisted	9
D8 twisted	15
On poles—	
D3, 9-in. spacing	29
D8, 9-in. spacing	48
Air lines—9-in. spacing—	
40-lb. bronze	75
40-lb. cadmium-copper	110
70-lb. cadmium-copper	170

TABLE III

APPROXIMATE RANGES FROM SWITCHBOARDS U.C. FOR BUZZER CALLING

Type of line. (1)	Approximate range in miles. (2)
Laid on ground—	
D3 twisted	6
D8, twisted	8
On poles—	
D3, 9-in. spacing	16
D8, 9-in. spacing	27
Air lines, 9-in. spacing—	
40-lb. bronze	44
40-lb., cadmium-copper	58
70-lb. cadmium-copper	87

In general reliable speech cannot be worked through a greater attenuation than 30-40 db. at 800 c/s.

These ranges apply to cable in good condition and having a minimum number of well made joints. Bad joints, dampness and the use of deteriorated cable may reduce the range by more than 50 per cent.

The range for magneto generator calling depends on the conductor resistance and on the leakage resistance of the line. As the latter varies considerably no precise figures can be given but as a rough guide the distances of 10-15 miles for D3 single and 15-20 miles for D8 twisted may be accepted.

A single line and earth circuit may give better or worse ranges than a twin line. In general the earth circuit tends to give better and better results relative to the twin line as the distance increases.

4. *Constructional details.*—

i. *Switchboards U.C. 10-line* (*see* Plates III and IV.)—The Switchboard U.C. 10-line, as has already been stated, is constructed on the unit principle.

(*a*) The common apparatus unit (*see* Plates V and VI).

The common apparatus unit, which is situated at the right-hand of the switchboard, contains a buzzer and a magneto generator for calling purposes together with a condenser and resistance which form part of the anti-side-tone circuit and the night alarm relay. The control panel carries a two-way key switch S_1 marked "SPEAK-BUZZ", a "NIGHT ALARM" jack and a "BATTERY PULL ON" switch S_2. The buzzer, which is removable from its compartment, is situated at

the top of the panel and the magneto generator is at the bottom. The generator has a folding handle which, in the operating position, allows convenient turning. It folds back to clear the lid of the case when closed for transport.

(*b*) The line units (*see* Plates VII and VIII).

Ten line units, to which lines from subscribers are connected, occupy the centre portion of the switchboard. Each line unit carries on the front panel an indicator lamp, a small white ivorine plate on which the identity of the subscriber may be pencilled, and two jacks, " A " and " B."

Spare line units are available for the maintenance of the 10-line switcboard. Each spare line unit is carried in a teak box (Boxes, Spare, for Line Unit) lined with baize and fitted with a sliding lid. The bottom of the box is lined with a strip of sponge rubber to protect the line unit from damage during transport.

(*c*) The operator's unit (*see* Plate IX).

The operator's unit is situated at the left-hand end of the switchboard case.

By means of this unit the operator's microphone and receiver may be connected to the line units, thus enabling him to communicate with distant subscribers. The panel carries the " OPERATOR'S JACK " and a four-point socket marked " M.R.R.M." which takes the four-pin plug of the operator's microphone and receiver.

The operator receives visual indication of calls and connects subscribers together by a system of weighted cords carrying plugs which are inserted in jacks on the line units (Plate III).

The current for the switchboard is provided by a battery of three cells (Cells, Dry, X, Mk. II ; or Cells, Inert S, Mk. I) contained in a removable box behind the line units in the back of the case, connections being made to the battery box by means of plugs and cords. Terminals are provided on the line terminal panel at the back of the switchboard for the connection of an external battery if desired.

The casing of the instrument is of aluminium alloy. A hinged lid at the front can be lowered to a horizontal position and gives access to the switchboard controls. The lid, which acts as a cord-shelf, is perforated and is fitted with a slotted sliding plate for supporting the plugs (attached to the pulley weights and cords) in a convenient position for operating. The cord-shelf, when open, may be screwed to a wooden

bench or table by wood-screws in order to give the switchboard greater rigidity. Two holes, one at each end, near the hinge, are provided for this purpose (Plate I).

At the back of the switchboard an upper hinged lid gives access to the line terminals which are mounted on a bakelised cambric panel while a lower hinged lid gives access to the battery box, the night bell and the interior of the switchboard. Two test resistances marked " OPERATE " and " NOT TO OPERATE " are held in clips on the lower lid. Two bakelite strips, to which the units are screwed, are mounted inside the switchboard case, one at the top and one at the bottom. The lower strip carries two bus bars which supply current from the battery to the units, contact being made through the two lower screws which secure each unit in position. Connection between the line units and the line terminals is made through the upper securing screws and a cable form.

Spare bulbs for use in the indicator lamps are carried in a holder in the switchboard and are accessible by opening the lower rear lid.

ii. *Switchboards U.C. 6-line* (*see* Plates XV and XVI).—The Switchboard U.C. 6-line is similar in construction to the Switchboard U.C. 10-line except that U-links are provided on the terminal panel for connection of a Superposing Unit (One Transformer) when required. The terminal panel also carries dummy U-link sockets and two spare U-links.

The night bell used with the 6-line board is carried in an accessory box instead of in the switchboard itself.

Pulley weights are not normally provided for the 6-line switchboard but may be demanded separately if required.

Spare line units in boxes are available for the maintenance of the Switchboard U.C. 6-line.

iii. *Accessory box* (*see* Plates I and XIII).—Miscellaneous equipment, such as the operator's microphone and receiver, plugs, cords, and pulley weights, is carried in a separate accessory box, constructed of aluminium alloy. This box clips on to the end of the switchboards and is further secured by screws.

At a Divisional Headquarters Office the microphone and receiver normally comprises a head and breast set (Transmitter Breast No. 1 and Receivers Headgear C.L.R. double, Mk. VI) while at Brigade and Regimental Headquarters a handset (Telephone, Hand, No. 2) is used.

iv. *Earth connections*.—Earth returns are connected to Pipes, Earth, Mk. III, which are perforated, pointed, mild-steel tubes about 3 feet long carrying a terminal at the upper end. The pipes are driven into the ground in the vicinity of the equipment.

v. *Superposing Units* (*Three Transformer*) (*see* Plates I, II, XVIII and XIX).—The Superposing Unit (Three Transformer) is enclosed in an aluminium alloy case with a hinged lid. It is designed to be mounted on top of the Switchboard U.C. 10-line to which it may be secured by links and screws. The superposing unit consists essentially of three transformers (Transformers Superposing, No. 1) of 1 : 1 ratio, mounted on aluminium alloy brackets which are secured to the underside of a bakelised paper panel. The top of the panel carries terminals and U-links and the underside, in addition to the transformers, two five-pair sockets which take the plugs of the five-pair cables. This panel is screwed in position in the case by three 2 B.A. cheese-headed screws. The plugs of the five-pair cables are inserted in the two five-pair sockets through two apertures in the front of the case. The colour coded insulated wires which are connected to the line terminals of the switchboard, pass through a slot in the case situated between the two five-pair sockets. The wires are held at the slot in an ebonite clamp and pass through another slot in the rear lid of the switchboard to the line terminals. A canvas flap attached to the superposing unit protects the exposed wiring.

A jumpering connector (Superposing Units (Three Transformer), Connector), consisting of a cord carrying a two-pin plug at each end, is provided for the cross connection of transformers in the event of the failure of a line on which superposing is being carried out. The use of this connector is described in Sec. **2**, para. (3) (iv). When the connector is not in use the plugs are inserted in dummy sockets on the panel (Plate XVIII).

vi. *Superposing Units* (*One Transformer*) (*see* Plates XIII, XIV, and XVI).—The Superposing Units (One Transformer) may be used with the Switchboards U.C. 6-line and also with the 10-line boards if superposing is required on more than three lines. For a complete description and working instructions of this instrument reference should be made to Signal Training, Vol. III, Pamphlet No. 20, " Superposing Units (One Transformer)."

2. Technical description

1. *Switchboards U.C. 10-line.*

i. *General.*—The Switchboard U.C. 10-line, has been designed to operate with either buzzer or magneto generator calling. It is built on the unit principle, each unit being supplied with current from two bus bars connected to the battery, the connections being shown in Fig. 1 and also Fig. 10.

The operator's telephone circuit, which is incorporated in the switchboard, includes an anti-side-tone circuit.

ii. *The circuit.*—The circuits of the switchboard are shown in Figs. 1 and 2. Subsidiary diagrams, Figs. 3 to 10, show the essential arrangements of the circuit in the following conditions :—

(*a*) Receiving magneto generator or buzzer calls (Fig. 3).
(*b*) Answering magneto generator or buzzer calls (Fig. 4).
(*c*) Speech communication between operator and calling subscriber (Figs 5 and 6).
(*d*) Calling subscriber by magneto generator (Fig. 7).
(*e*) Calling subscriber by buzzer (Fig. 8).
(*f*) Speech communication between operator and called subscriber.
(*g*) Speech communication between two subscribers (Fig. 9).
(*h*) Night alarm circuit (Fig. 10).

In following the circuit it will be convenient to consider these various conditions of use of the switchboard.

(*a*) Receiving magneto generator or buzzer calls (Fig, 3).

Alternating currents from a subscriber's instrument, at ringing or buzzer frequencies, enter the switchboard at the line terminals L1, L2 and pass through the contacts of the " A " jack on the line unit associated with the subscriber to the bridge rectifier RECT. 1. The rectified current operates the relay REL. 1 through the operating winding " O." The closing of the contacts on this relay causes the lamp on the front of the unit to light, thus indicating to the operator when a call has been received. The closing of the contacts also allows current from the battery to pass through a holding winding " H " which keeps the relay closed after the calling current has ceased.

(*b*) Answering magneto generator or buzzer calls (Fig. 4).

When answering a call the operator's plug is inserted in the " A " jack on the line unit concerned. This action breaks the lamp circuit through the holding winding of the relay and extinguishes the lamp.

NOTE.—The operator's plug is connected by a cord to the operator's telephone and enables him to speak to the calling subscriber.

(*c*) Speech communication between operator and calling subscriber (Figs. 5 and 6).

When the operator has inserted his plug in the " A" jack in answer to a call he can communicate with the subscriber by placing the " SPEAK-BUZZ " key switch at " SPEAK."

The switchboard circuit for this condition is shown in Fig. 5. The microphone circuit includes a 15 ohm resistance R2 to limit the microphone current, which might otherwise cause " frying " noises in the receiver, the speech currents being shunted by the 250μ F electrolytic condenser C_2. When the " SPEAK-BUZZ " key switch is at " SPEAK," current is taken from the battery and passes through the limiting resistance R_2 and through the microphone and primary windings of the buzzer. Speech into the microphone then induces voltages into the secondary windings of the buzzer and thence to the line. The step-up transformer ratio of the buzzer used in this way is about $3\frac{1}{2}$ to 1. The function of the anti-side-tone* circuit is more clearly seen by reference to the left-hand section of Fig. 6, which shows it in the form of an A.C. Wheatstone bridge. The arms of the bridge are formed by the two secondary windings of the buzzer on the one side and by the line and balancing network comprising the 400 ohm resistance R_1 and the 0·5 F condenser C_1 on the other.

The condition of balance, when there is no voltage across the receiver is set up when :—

$$S_1 : S_2 : \quad : Z_L : Z_B,$$

where S_1 and S_2 = the impedance of the secondary winding of the buzzer.

Z_L = the impedance of the arm of the bridge which consists of the line network.

Z_B = the impedance of the balancing network C_1 and R_1.

The value of Z_B is chosen to represent an average line impedance met with in normal usage. Speech voltages set up in the secondary do not disturb the degree of balance of the bridge and consequently the side-tone heard in the receiver is maintained at a value determined by the out of balance of the bridge. For average lines this out of balance gives a suitable amount of side-tone. A " crash limiter " X_1 (Fig. 5) to protect the operator from acoustic shock caused by key clicks, or other forms of transient interference is permanently connected across the receiver of the operator's telephone.

---

*Note.—By side-tone is meant the property of a telephone instrument whereby the operator hears his own voice in the receiver when he speaks into the microphone. While this shows the operator that his microphone is working properly, the suppression of side-tone to a low value has the following advantages :—

(1) In noisy surroundings, the unwanted noise reaching the operator's microphone does not materially affect his receiver and consequently does not interfere with the reception of incoming signals.

(2) The low value of side-tone tends to make the operator speak more loudly and clearly than he would if side-tone were loud.

This comprises a metal rectifier unit consisting of two metal rectifiers connected in parallel, but in opposite polarity, across the operator's receiver. When an A.C. speech voltage is applied, this arrangement of rectifiers conducts equally in both directions and hence appears as a resistance to the A.C. current. Owing to the curvature of the characteristic of the metal rectifier at low voltages the resistance to A.C. of this device decreases rapidly as the applied voltage is increased. The resistance is high to ordinary signal voltages but for those due to interference which rise above the ordinary signal voltages the resistance becomes low and shunts the receiver. This has the effect of reducing noises due to interference to the level of the speech signals.

(*d*) Calling subscriber by magneto generator (Fig. 7).

When calling by magneto generator the process of turning the handle operates a switch which connects the magneto generator across the operator's jack and hence across the line of the called subscriber, and also disconnects the remainder of the operator's telephone circuit.

(*e*) Calling subscriber by buzzer (Fig. 8.).

When calling by buzzer, pressing the "SPEAK-BUZZ" key switch to "BUZZ" disconnects the operator's microphone and receiver and energises the buzzer by completing the battery circuit through its primary windings. At the same time the 400 ohm resistance R_1, and the $0{\cdot}5\mu$ F condenser C_1 (Fig. 1) are short circuited so that the maximum output is applied to the line.

(*f*) Speech communication between operator and called subscriber.

The circuit for this condition is similar to that given in Fig. 5.

(*g*) Speech communication between two subscribers (Fig. 9).

Fig. 9 shows the circuit when the operator has connected two subscribers' lines by a cord. It will be seen that the "B" jack of the calling subscriber is connected to the "A" jack of the called subscriber. The two "B" jacks are not connected together as this would result in a resistance, consisting of two bridge rectifiers RECT. 1, in parallel, being connected across the line. Such a resistance is low enough to attenuate the speech currents considerably.

Reference to Fig. 9 will show that if either of the subscribers rings off, the indicator on the line unit of the calling subscriber will again light. This is extinguished, as already explained in (*b*) above when the operator inserts his plug into the "A" jack on the same unit to enquire if conversation is finished.

(*h*) The night alarm circuit (Fig. 10).

When the night alarm circuit is set up as shown in Fig. 10, receipt of a call from any one of the subscribers results in the continuous ringing of the night bell.

When the holding circuit of the relay REL. 1 is completed, the current from the battery passes through the night alarm relay REL. 2 and closes the contacts of this relay. This provides a path for the ringing current of the bell from the positive pole of the battery, through the " BATTERY PULL ON " switch and the winding of the night alarm relay REL. 2, through the night bell and via the contacts of the night alarm relay back to the negative pole of the battery. The bell will cease ringing when the operator's plug is inserted in the " A " jack of the calling subscriber's line unit.

This action breaks the circuit of the holding winding " H " of the relay REL. 1, and current ceases to flow through the windings of the night alarm relay REL. 2.

iii. *The common apparatus unit* (*see* Plates V and VI).—This unit comprises the following apparatus mounted on an aluminium panel and a brass base plate, the panel being supported by a brass strengthening bracket :—

(*a*) The buzzer (Buzzers T, Mk. I).
(*b*) The magneto generator (Generators B).
(*c*) The night alarm relay, REL. 2.
(*d*) The " SPEAK-BUZZ " key switch S_1.
(*e*) The " BATTERY PULL ON " switch S_2.
(*f*) The " NIGHT ALARM " jack.
(*g*) The 0·5 μF condenser C_1 and the 400 ohm resistance R_1.

Electrical connections between the common apparatus unit and other parts of the switchboard circuit are made by colour-coded insulated wires run in cable forms.

The following is a brief description of the chief components of the common apparatus unit :—

(*a*) The buzzer (Buzzers, T, Mk. I, *see* Plate VI).

The buzzer performs three particular functions :

It operates as an A.C. generator in the form of a step-up transformer with " interrupted " primary winding for calling. The secondary winding operates as the two arms of an A.C. bridge network for the suppression of side-tone (*see* Fig. 6). The windings (primary and secondary) form a microphone transformer.

The Buzzer, T, Mk. I, is fully described Sinignal Training, Vol. III, Pamphlet No. 22, " Telephone Sets, D, Mk. V," and Pamphlet No. 23, " Telephone Sets, F, Mks. I and I*."

Connections between the buzzer and the remainder of the circuit are made through spring contacts on the bottom of the buzzer compartment.

(*b*) The magneto generator (Generators, B, *see* Plate VI).

The magneto generator is of Post Office design. A full description of this type of instrument is given in "Signal Training" (1936), Volume II, Part III, Sec. **15.**

NOTE.—It will be seen that in the Switchboard U.C. 10-line the magneto generator and bell are connected in a *shunt* type of circuit and the description given in "Signal Training" deals with circuits which are of the *series* type.

The arm of the magneto generator handle has a flat against which a knurled locknut is tightened when in the operating position. When the locknut is released the handle is folded back so that the front lid of the switchboard may be closed (*see* Plate V).

(*c*) The night alarm relay (Switchboard U.C. Relay Alarm, *see* Plate VI).

The night alarm relay is mounted at the rear of the common apparatus unit. The windings, which are connected in series, are on two bobbins of 0·1 ohm resistance each. The cores of the windings are of "MU-metal" and are secured to a "MU-metal" block at the base of the relay. Two shaped "MU-metal" blocks secured to the upper ends of the cores complete the stationary part of the magnetic circuit. The gap between these pole pieces is closed by the armature when the relay is operated.

The armature of the relay is of "Radio-Metal" held by screws at its lower end and has a platinum contact at its upper end. Two contact screws, one carrying a platinum tipped contact and the other an insulating stud are mounted in a metal block on top of the "MU-metal" blocks and insulated therefrom by a bakelite strip. The armature normally rests against the insulating stud. The relay is adjusted by a bias screw situated at the base of the relay between the bobbins. The bias screw has a conical point and, when screwed down, forces a pin against the lower part of the armature thereby moving it away from the relay contact screw. Unscrewing the bias screw allows the armature to move back in the opposite direction.

(*d*) The "SPEAK-BUZZ" key switch S_1 (Switch, Speak/Buzz, *see* Plates V and VI).

The "SPEAK-BUZZ" key switch S_1 is a double throw type key switch. The packing and thickness of the studs of the "SPEAK" springs is greater on the side which connects the receiver in circuit so that the microphone connections are made before those of the receiver. This prevents a sudden rise of current in the secondary of the microphone transformer which would produce an unpleasant "click" in the receiver were the "microphone" contacts made first, or "microphone" and "receiver" contacts made simultaneously. The key switch locks when the handle is at "SPEAK."

(*e*) The "BATTERY PULL ON" switch S_2 (Switch Battery, *see* Plates V and VI).

The "BATTERY PULL ON" switch S_2 has a handle of such a length that, when the front lid of the switchboard is closed the switch is pushed in and the battery disconnected.

(*f*) The "NIGHT ALARM" jack (Jack, No. 500A, *see* Plates V and VI).

The "NIGHT-ALARM" jack is a two-way jack mounted in the centre of the front panel.

(*g*) The 0·5 μF condenser C_1 (Condenser P_5C) and the 400 ohm resistance R_1 (Resistor No. 2B or No. 3B, ½ watt 400 ohms) (*see* Plate VI).

The 0·5 μF condenser C_1 and the 400 ohm resistance R_1 which form the balancing network of the anti-side-tone circuit are secured to the base of the common apparatus unit.

iv. *The line units* (*see* Plates VII and VIII).—The ten line units are of similar construction. The apparatus for each unit is mounted on a panel of insulating material. This panel is secured to the bakelite strips in the switchboard case by four captive screws. The two screws at the top afford connections to the line terminals while those at the bottom are connected to the bus bars supplying current from the battery. The right-hand screw is connected to the positive pole of the battery while the left-hand screw is connected to the negative pole.

On the line unit panel are mounted :—

(*a*) The indicator lamp (Plate VIII).

The indicator lamp consists of a 3·5 volt, 0·15 ampere miniature screw type bulb (Bulbs, 3·5 volt, K.).* It is screwed into a thick metal

* In later issues of Switchboards U.C. 10-line and 6-line this bulb will be replaced by one having a higher voltage rating and longer life.

collar which slides in a cylindrical holder fixed to the panel. The centre contact of the bulb presses against a spring contact pin, the other connection being made through the collar and a spiral contact spring. The cover, which carries a window bearing the number of the subscriber, is held in position by bayonet slots. When the lamp is assembled the bulb and collar are forced against the contact pin and spring respectively by the cover.

(*b*) The bridge rectifier, RECT. 1 (Figs. 2, 3 and 4).

This is a metal rectifier, type 4/4/1B.

(*c*) The " A " jack (Jack, No. 800A) and the " B " jack (Jack No. 500A) (*see* Plate VII).

The " A " jack is mounted below the " B " jack on the line unit panel.

(*d*) The relay (Switchboards U.C. Relay Line, *see* Plate VII).

The construction of the relay REL. 1 is similar to that of the night alarm relay REL. 2 except that there are two windings on each bobbin, the operating winding " O," and the holding winding " H."

The operating winding has a total resistance of 800 ohms and the holding winding has a total resistance of 1·38 ohms.

v. *The operator's unit* (*see* Plate IX).—The apparatus for the operator's unit is mounted on a panel of insulating material which is secured in the switchboard case in a similar manner to the line units. Electrical connections between the operator's unit and other parts of the circuit are made by a colour-coded cable form.

On the panel are mounted :—

(*a*) The operator's jack (Jack No. 500A).

Each of the two springs of the operator's jack is connected to one of the captive screws at the top of the panel. When the unit is in position in the case these screws are connected to the appropriate components on the common apparatus unit by wires in the cable form.

(*b*) The 250 μF electrolytic condenser C_2 (Condenser 250A) and the 15 ohm resistance R_2 (Resistor No. 2B or 3B, $\frac{1}{2}$ watt, 15 ohms).

These are screwed to the back of the panel.

(*c*) The four-point jack (Jack No. 8).

This jack takes the four-pin plug of the operator's microphone and receiver. The two

outer sockets, marked " M " are connected in the microphone circuit and the two inner sockets, marked " R," are connected in the receiver circuit of the operator's telephone.

The two captive screws at the bottom of the panel have no electrical connections made to them and serve only to secure the operator's unit in position.

(*d*) The " crash limiter."

This is a dry metal rectifier (Rectifier, Metal, 2/2A) mounted on the four-point jack.

vi. *The battery box* (*see* Plates IV and XVI).—The battery box, which slides in grooves in the switchboard case, is of aluminium alloy painted inside with acid resisting paint. The hinged lid is lined with bakelised cambric in order to prevent any possibility of short-circuits. Connections to the battery of three Cells, Dry, X, Mk. II or Cells, Inert, S, Mk. I, are made inside the battery box by means of flexible leads connected to insulated sockets mounted in the sides of the box. Connections from the switchboard to the battery box are made by flexible leads ending in plugs P_1 and P_2 which are inserted in these sockets.

The cells are held in position by wooden packing pieces covered with acid resisting paint.

vii. *The operator's microphone and receiver.*—

(*a*) Transmitter, Breast, No. 1 (*see* Plates III and X).

The Transmitter, Breast, No. 1, is used with Switchboards U.C. 10-line for Divisional Headquarters use. It consists of a black bakelite moulded case, containing the microphone capsule (Microphone, Capsule, Mk. IV) mounted on a bakelised cambric plate. This plate also carries supporting straps and tapes. The mouthpiece is screwed to a ball and socket joint and is held in position, when screwed in, by a sliding catch.

A microphone switch is incorporated in the transmitter casing which breaks the circuit when the mouthpiece is turned downwards. The transmitter is connected in circuit by a two-point plug in the casing, which takes a special two-point socket (Transmitter, Breast, No. 1, Socket) attached to the leads of the operator's headphones.

(*b*) Microphones, Respirator, No. 2 (*see* Plate XI).

The Microphone, Respirator, No. 2, not normally issued with the switchboard, is a transmitter designed to enable the operator to work the switchboard while wearing a respirator. It

consists of a black bakelite case housing a Microphone, Capsule, Mk. V.

The case has a tubular projection which fits into an aperture in the facepiece of the respirator, the respirator being clamped to the microphone with a circular clip. An ebonite plug is provided to fill the aperture in the respirator when the microphone is not used.

The case has a plug similar to that on the Transmitter, Breast, No. 1, to take the two-point socket of the operator's headphones.

(*c*) Receivers, Headgear, C.L.R., Double, Mk. VI (*see* Plate III).

The Receivers, Headgear, C.L.R. Double, Mk. VI, used with the Switchboards U.C. 10-line at Divisional Headquarters, are of the watch receiver type. The cord which connects them to the four-pin plug (Plug, No. 406) carries a two-point socket (Transmitter, Breast, No. 1, Socket), which is inserted into the two-point plug on the Transmitter, Breast, No. 1, or Microphones, Respirator, No. 2. The four-pin plug is inserted in the socket marked " M.R.R.M." on the operator's unit.

(*d*) Telephones, Hand, No. 2 (*see* Plates XII and XV).

The Telephone, Hand, No. 2, is a handset used with Switchboards U.C. 10-line at Brigade Headquarters and with the Switchboards U.C. 6-line. It consists of a handset moulding containing the Receiver, Inset, No. 1L, and the Microphone, Capsule, Mk. IV. A pressel switch is incorporated.

viii. *The plugs, cords and pulley weights* (*see* Plate III).—Each assembly consists of a 3-ft. length of cord (Cords, Switchboard, No. 242) coloured either red or black, terminating in two-way plugs (Plugs, No. 201). A pulley weight (Pulley, Weight, No. 16) is attached which keeps the cord taut when the assembly is mounted in position for use.

ix. *The night bell* (Bell, Battery, No. 13A (Modified) ; *see* Plates III, IV, and XV).—This bell assembly consists of a D.C. electric bell mounted on a bakelised cambric plate and provided with terminals fitted to a block of insulating material. The two coils are connected in series and are of 50 ohms resistance each. The bell is connected to the " NIGHT ALARM " jack by a connector consisting of a length of twin flex (Wire, Electric, Q.13, Mk. I) carrying connecting lugs at one end and a two-way plug (Plugs, No. 201, Black) at the other.

x. *The test resistances* (Resistance Test, 1,960 ohms and Resistance Test, 2,960 ohms, *see* Plates IV and XVI).—The two wire wound test resistances are mounted in spring clips on the back lid of the switchboard. That marked "OPERATE" has a resistance of 1,960 ohms while that marked "NOT TO OPERATE" has a resistance of 2,960 ohms, The use of these resistances is explained in para. (4) (ii) of Sec. **3**, "WORKING INSTRUCTIONS."

2. *Switchboards U.C. 6-line.*

The Switchboard U.C. 6-line, shown in Plates XIII to XVI, is similar in design to the Switchboard U.C. 10-line except that only six line units are employed. A handset (Telephones, Hand, No. 2) is provided for the operator's use instead of the headphones and breast transmitter.

The foregoing description therefore, fully covers the circuit of the Switchboard U.C. 6-line.

3. *Superposing Units (Three Transformer).*

i. *General.*—The Superposing Unit (Three Transformer), as already stated, provides facilities for superposing Fullerphones or telephones on lines 1, 2 and 3 of the Switchboard U.C. 10-line by means of three superposing transformers (Transformers, Superposing, No. 1) which may be connected between the lines and the switchboard.

ii. *The circuit.*—The complete circuit of the superposing unit is shown in Fig. 11. It is so designed that both *superposing series* and *superposing phantom* methods may be employed. The principles of superposing (telephony and telegraphy) together with phantom circuit descriptions are given in "Signal Training" (1936), Volume II, Part III, Chapter XI, Sec. **43**, paras. 1, 4 and 6. The most general arrangements are described in Signal Training, Vol. III, Pamphlet No. 20, "Superposing Units (One Transformer)," Sec. **2**, paras. 2 and 3, and may be summarised as follows :—

(*a*) Series Fullerphones superposed on a twin line, or single line and earth telephone circuit.

(*b*) Phantom to earth Fullerphone or telephone circuit superposed on a twin line.

(*c*) Phantom Fullerphone or phantom telephone circuit superposed on two twin lines.

(*d*) Development of phantom pair arrangement—One Fullerphone (or telephone) phantom to earth circuit, and one phantom telephone circuit superposed on two twin lines.

(*e*) Intermediate Fullerphone or telephone circuit superposed on a twin line and earth.

(*f*) Intermediate Fullerphone or telephone circuit superposed on two twin lines.

Connections are facilitated by the terminal markings on the panel of the Superposing Unit (Three Transformer) being similar to those on the Superposing Unit (One Transformer).

When phantom superposing is used the F.S. terminals are connected by a U-link instead of by a short length of wire as in the Superposing Units (One Transformer). This U-link is removed and placed in a dummy socket in the panel when series superposing is required.

iii. *Transformers, Superposing, No.* 1.—The transformer is wound toroidally on a ring core. The primary and secondary windings are each in two separate and equal halves and have a 1 : 1 ratio. The inductance of each winding is approximately 7 henries at 300 c/s with one volt applied.

iv. *The panel* (*see* Plates XVIII and XIX and Fig. 11).—The panel of the Superposing Unit (Three Transformer) carries three sets of terminals for connecting the superposed instruments (Fullerphone or telephone) in circuit. These sets are marked 1, 2 and 3 and refer to lines 1, 2 and 3 on which superposing is normally carried out.

Two five-pair sockets, shown red and black, which take the plugs of the five-pair cables are secured to the underside of the panel at the rear. Connections are made from these to the rear row of U-link sockets mounted at the front of the panel.

The U-link sockets in the front row, with the exception of those marked 1, 2 and 3 are attached to colour-coded insulated wires which are secured to the line terminals of the switchboard. The front U-link sockets marked 1, 2 and 3 are connected to the secondary windings of the superposing transformers as shown in Fig. 11. The primary windings are connected to the switchboard line terminals by colour-coded insulated wires.

U-links are provided to connect the sockets as shown in Fig. 11.

If one of the lines 1, 2 or 3 should fail, superposing may be carried out on another line by means of a cord carrying a two-pin plug at each end (Superposing Units (Three Transformer) Connector). One plug is inserted into the front U-link sockets of the faulty line while the other is inserted into the rear sockets on the line on which superposing is to be carried out.

3. Working instructions for Switchboards U.C. 10-line

1. *Preliminary.*—When possible the switchboard should be screwed to a table or other support off the ground.

When the switchboard is used with the Superposing Units (Three Transformer) the following instructions should be carried out commencing from sub-para. i, below. **When**

the switchboard is used alone the instructions should be carried out commencing from sub-para. xii, below.

i. Uncover the small hole in the centre of the rear lid on top of the switchboard as follows :—

(*a*) Remove the short screw at the left-hand end of the covering strip (as seen from the rear of the switchboard) and loosen the nut and screw at the right-hand end.

(*b*) Remove the nut and screw from the third small hole (to the right of the slot), turn the strip round to uncover the slot completely and secure it in this position with the short screw from the left-hand hole. Place the spare nut and screw in the hole at the left-hand end of the slot.

ii. Place the case of the Superposing Units (Three Transformer) on the top of the switchboard at the front with the piano hinge facing the operator (*see* Plate I).

iii. Remove the cheese-headed screws from the ends of the superposing unit and loosen the counter-sunk screws so that the two links at each end hang down vertically. Secure the links on the right-hand side as seen from the rear, to the switchboard with the cheese-headed screws which must pass through the holes in the links and be screwed into the threaded holes provided on the switchboard.

Replace the two cheese-headed screws in their holes at the left-hand end of the box.

iv. Place the tongue of the accessory box in the clip on the left-hand end of the switchboard, as seen from the rear, and secure the top portion by means of the screws provided. Access to these is gained by opening the lid of the accessory box.

The screws must pass through the holes in the links attached to the superposing unit. In this way both the accessory box and the superposing unit are secured to the switchboard.

Tighten all screws so that the parts are firmly held together.

v. Pass the colour-coded insulated wires, attached to the superposing unit, through the slot in the centre of the rear lid on the top of the switchboard and connect them to the line terminals beneath, as shown in Fig. 11 and Plate IV.

vi. Select the type of superposing required from the circuits given in Sec. **2**, para. 3, ii of this pamphlet and also in Sec. **2**, paras 2 and 3 of the pamphlet entitled Superposing Units (One Transformer).

vii. Unfasten and open the lid of the superposing unit.

viii. Connect the instruments (Fullerphones or telephones) to be superposed to the appropriate terminals on the panel of the superposing unit according to the type of circuit selected (*see* Signal Training, Vol. III, Pamphlet No. 20 "Superposing Units (One Transformer)"). Care should be taken that the U-links connecting the F.S. terminals together are inserted for phantom superposing and removed for series superposing.

NOTE.—A maximum of three instruments may be employed with this superposing unit and these are superposed on lines 1, 2 and 3. If one of these lines fails, the superposing may be carried out on another line as follows :—

(1) Remove the jumpering connector from the panel of the instrument.

(2) Remove the two U-links from the sockets connected to the faulty line, and place them in the dummy sockets in the panel.

(3) Remove the two U-links from the sockets connected to the line on which superposing is to be carried out and place them in the dummy sockets on the panel.

(4) Insert one plug of the jumpering connector into the two front U-link sockets of the faulty line and the other plug into the two rear sockets of the line over which superposing is to be carried out.

These connections enable a line unit and its associated superposed instrument to be transferred from a faulty line to one in good condition. Also it will be seen from Fig. 11 that the line unit originally connected to the line in good condition is now disconnected.

ix. Close the lid of the superposing unit, arranging that the wires connected to the terminals on the panel pass out under the curved portion of the lid.

NOTE.—Wires must not be allowed to pass out at the ends of the superposing unit as they are liable to be cut through and the connections broken when the lid is closed.

x. Insert the plugs terminating the five-pair cables in the sockets on the superposing unit. The red plug is inserted in the red socket and the black plug in the black socket.

xi. Additional superposing may be carried out with the Superposing Unit (One Transformer). The superposing unit may be connected, by the plugs and cords with which it is provided, to the appropriate U-link sockets on the Superposing Unit (Three Transformer). Particulars of these connections, which are similar to those made to the Switchboards U.C. 6-line, are given in the pamphlet entitled "Superposing Units (One Transformer)" (Signal Training, Vol. III, Pamphlet No. 20).

xii. If the switchboard is being used without the Superposing Units (Three Transformer), secure the accessory box as in sub-para. iv, above, and connect the lines to the line terminals at the rear.

IMPORTANT NOTE.—When earth return lines are used the earth pipes should be spaced at least 10 yards from each other.

xiii. Unfasten the catches on the front lid or cord shelf of the switchboard, by turning them inwards, and lower the cord shelf. If the switchboard stands on a table or other support off the ground, arrange that this cord shelf projects beyond the front of its support.

NOTE.—If required the switchboard may be fixed to a wooden support by wood screws which are inserted through two holes provided in the cord shelf near the hinge.

xiv. If the switchboard stands on a support unscrew the knurled knobs on the inside of the cord shelf and slide the perforated plate out until the circular portions of the perforations uncover those in the cord shelf.

xv. Thread the two plugs of each cord, which will be found in the accessory box, through a pair of holes from below. The weights must be laid on the cord shelf during this operation in order that the plugs shall not be pulled through the holes.

xvi. Slide the perforated plate still further out so that the plugs are prevented from falling through the holes and remove the weights, allowing them to hang beneath the cord shelf. All the plugs should now be pointing upwards from the cord shelf, the cords hanging in loops being held taut

by the pulley weights (*see* Plate III). If the switchboard is used on the ground the cords may be laid out in front.

xvii. Remove the headphones and breast transmitter, if carried, from the accessory box and insert the two-point socket carried on the headphones cord into the plug provided on the transmitter.

xviii. Screw the mouthpiece into the transmitter casing and secure it in position *opposite the mouth* by means of the sliding catch on the side of the mouthpiece.

NOTE.—The proper location of the mouthpiece by means of this catch is essential for the correct functioning of the microphone switch. This switch is incorporated in the transmitter casing and is " broken " when the mouthpiece is turned round in its ball socket until it points downwards. In the normal position for operating the switch is " made."

xix. Insert the four-pin plug on the headphones cord or on the cord attached to the Telephone, Hand, No. 2, if used, in the four-point socket marked " M.R.R.M." on the operator's unit.

xx. Bring the magneto generator handle into the operating position as follows :—

(*a*) Unscrew the knurled locknut a few turns.

(*b*) Turn the handle towards the front of the switchboard.

(*c*) Lock the handle in this position by screwing up the locknut.

xxi. Lower the rear lid of the switchboard. Then remove the battery box by first withdrawing the connecting plugs P_1 and P_2 (Plate IV) from their sockets on the box and sliding it out.

xxii. Open the lid and see that the three Cells, Dry, X, Mk. II, or three Cells, Inert, S, Mk. I (activated) in good condition are in place. They should be connected in series and the red and black leads connected to the positive and negative terminals respectively (*see* Plate XVI).

Take care that the terminals are clean and that good contacts are made.

xxiii. Replace the battery box and close the rear lids of the switchboard, the lower first and then the upper.

NOTE.—When lines are connected directly to the switchboard terminals see that they pass out

through the louvre of the upper rear lid. Wires must not be allowed to pass out at the ends as they are liable to be cut through and the connections broken when the lid is closed.

xxiv. See that the buzzer is correctly adjusted (*see* Sec. **3**, para. 4, vi, below).

xxv. Insert a plug of the nearest cord in the operator's jack. *The plug at the other end of the cord is referred to below as the operator's plug.*

xxvi. Pull out the " BATTERY PULL ON " switch and apply the lamp tests as in Sec. **3**, para. 3, i, below.

If there is much traffic through the switchboard an external battery of larger capacity may be connected to the terminals on the line terminal panel marked " EXT. BATT." The plugs P_1 and P_2 must be removed from the battery box and inserted in the sockets marked " EXT. BATT." attached to the interior of the case.

In dismantling the apparatus perform the operations given above in sub-paras. i to xx, but in the reverse order.

2. *Operating the switchboard.*

i. *To connect two subscribers.*—A call from a subscriber is indicated by the lamp carried on the subscriber's line unit lighting up.

(*a*) Insert the operator's plug in the " A " jack on the line unit concerned. The lamp will then be extinguished.

(*b*) Put the " SPEAK-BUZZ " key switch to " SPEAK " and enquire the connection required. While doing this insert a plug of a second cord into the " B " jack of the calling subscriber's line unit.

(*c*) On being informed of the connection required insert the operator's plug into the " A " jack on the appropriate line unit and give either a magneto generator or buzzer call.

A magneto generator call is given by turning the magneto generator handle a few times.

A buzzer call is given by pressing down the " SPEAK-BUZZ " key switch to " BUZZ " and then returning it to the " SPEAK " position.

A single dash only should be given in order that it may be recognized as a calling signal by Fullerphone operators. Any semblance of morse should be avoided.

(*d*) When the called subscriber answers, complete the connection between the two subscribers by first removing the operator's plug, and then inserting

the plug on the other end of the second cord mentioned in sub-para. (*b*) above into the " A " jack on the called subscriber's line unit.

IMPORTANT NOTE.—On no account should two subscribers be connected through their " B " jacks as this results in a shunt resistance, consisting of two rectifiers RECT. 1, in parallel, being connected across the line. This resistance is low enough to attentuate the speech current considerably.

(*e*) Return the " SPEAK-BUZZ " key switch to the neutral position.

NOTE.—In order to avoid wasting the battery, care should be taken that the " SPEAK-BUZZ " key switch be kept in the neutral position, except when the speech or buzzer circuits are actually required.

ii. *Clearing.*—When either of two connected subscribers rings off, the indicator lamp on the calling subscriber's line unit lights up.

(*a*) Insert the operator's plug in the " A " jack of the calling subscriber's line and listen. The indicator lamp will be extinguished.

(*b*) If nothing is heard ask " Have you finished ? " and if there is no reply, clear the line by withdrawing the two connecting plugs.

(*c*) If a call is received for an engaged subscriber insert the operator's plug in either one of the two vacant jacks on the engaged line units and if no speech is heard challenge by saying " Have you finished ? " If no reply is received clear the old connection and make the new one. A similar challenge may be made if a conversation appears to have lasted an abnormal length of time. It may sometimes happen that subscribers have omitted to ring off.

(*d*) Supervision can be effected at any time by inserting the operator's plug into a vacant jack on one of the line units of a connected pair of lines.

iii. *Bunched connections.*—When it is required to send a message to two or more subscribers the following procedure is adopted :—

(*a*) Call each subscriber in turn asking him to stand by.

(*b*) By means of the cords join the " B " jack of the first subscriber to the " A " jack of the second, the " B " jack of the second to the " A " of the third and so on.

(*c*) Insert the operator's plug into one of the vacant jacks of the bunched lines and deliver the message.

When it is necessary to connect a number of subscribers together operations (*a*) and (*b*), above, should be performed.

iv. *The night alarm.*—The night alarm is set up as follows :

(*a*) Remove the night bell from its position on the rear lower lid of the switchboard.

(*b*) Connect the lugs on the red and black twin connector (to be found in the accessory box) to the bell and insert the plug on the other end into the " NIGHT ALARM " jack.

(*c*) See that the " BATTERY PULL ON " switch is in the " on " position.

(*d*) Test the night alarm by applying the lamp test (*see* para. 3, i, below). When a lamp lights the bell should ring.

(*e*) Remove the plug of the night alarm connection from the " NIGHT ALARM " jack before answering a call.

(*f*) Replace the plug in the " NIGHT ALARM " jack before leaving the switchboard during a quiet period.

3. *Tests.*

i. *The lamps.*—

(*a*) Pull out the " BATTERY PULL ON " switch.

(*b*) Take a spare cord, and, holding the tip of one plug against the right-hand bottom screw head of any line unit, touch the holders of the lamps in turn with the tip of the other plug. Each lamp should light up while the tip of the testing plug is in contact with its lampholder.

ii. *Line unit circuit continuity.*—Insert the operator's plug into the " B " jack of the first line unit and give the magneto generator handle about half a turn. If the circuit is in order the indicator lamp should light.

Repeat the test for the other nine line units. The test may also be performed using a buzzer signal.

iii. *Line unit relay sensitivity.*—If it is thought that a relay has lost its sensitivity by going out of adjustment the following test should be applied :—

(*a*) Disconnect the line.

(*b*) Insert the operator's plug into the " B " jack on the line unit concerned.

(*c*) Pull out the " BATTERY PULL ON " switch.

(*d*) Put the " SPEAK-BUZZ " key switch to " SPEAK."

The lamp should light with moderately loud speech in the microphone. If on shouting, the lamp does not light, adjust the relay (*see* Sec. **3**, para. 4, ii, below).

iv. *The auxiliary contacts on the " A " jacks.*—If it is found that, on any line unit, the lamp does not extinguish readily on the insertion of a plug in the " A " jack, the auxiliary contacts which control the lamp circuit are out of adjustment. They should be readjusted as described in Sec. **3**, para. 4, (iii) below.

v. *The magneto generator.*—The magneto generator may be tested in either of the following ways :—

(*a*) If it can be used to actuate the lamps as in (ii) above, the magneto generator is in working order.

(*b*) Hold the tip and barrel of the operator's plug between the moistened finger and thumb of the left hand and turn the magneto generator handle with the right hand. A slight shock may be felt if the magneto generator is in working order.

vi. *The buzzer.*—With the " BATTERY PULL ON " switch out :—

(*a*) Press the " SPEAK-BUZZ " key switch to " BUZZ." The buzzer should be audible and at the same time a weak buzzing should be heard in the operator's headphones.

(*b*) Insert the operator's plug into the " B " jack of a line unit and press the " SPEAK-BUZZ " key switch to " BUZZ."

The indicator lamp on the line unit should light.

NOTE.—Tests vii and viii, (*a*) below, should be performed with the operator wearing the headphones and transmitter.

vii. *The operator's receiver* (Receivers, Headgear, C.L.R., Double, Mk. VI, and Telephone, Hand, No. 2).—Press the " SPEAK-BUZZ " key switch to " BUZZ." A weak buzzing sound should be heard in the operator's headphones. When the key is depressed or released a definite " click " should be heard in the receiver.

viii. *The operator's transmitter.*

(*a*) Transmitter, Breast, No. 1, and Microphone, Respirator, No. 2.

Put the " SPEAK-BUZZ" key switch to " SPEAK " and blow into the mouthpiece. A breathing sound should be heard in the receivers. Releasing the " SPEAK-BUZZ " key switch should at once cut off the sound.

(*b*) Telephone, Hand, No. 2.

Carry out the test described in (*a*) above keeping the pressel switch in the handle closed.

ix. *The transmitter switch on the breast transmitter.*—Turn the mouthpiece downwards. Then unstrap the transmitter and turn it so that the mouthpiece comes opposite the mouth again. No sound should be heard in the receiver on blowing into the microphone mouthpiece.

x. *The night alarm relay.*

(*a*) Set up the night alarm circuit by connecting the night bell to the lugs of the night bell connector and inserting the plug on the other end into the " NIGHT ALARM " jack on the common apparatus unit.

(*b*) Pull out the " BATTERY PULL ON " switch.

(*c*) Take a spare cord and holding the tip of one plug against the right-hand bottom screw head of a line unit, touch the case of the indicator lamp on the unit with the tip of the other plug.

When the lamp lights the night bell should ring.

4. *Adjustments.*

i. *To adjust the lamps.*—Faulty lamps should be replaced as described in Sec. 5, " Maintenance and repair," para. 8.

ii. *To adjust the line relays.*—The following tests may be performed without removing the line units. To reach some line units the battery box may have to be removed. Care should be taken to leave the battery connections intact.

(*a*) Connect the test resistance marked " OPERATE " in series with a 4·5-volt battery across the line terminals associated with the faulty relay.

(*b*) Adjust the bias on the armature by means of the bias screw, which will be found at the top of the pillar between the coils, until the armature pulls over.

(*c*) Replace the resistance marked " OPERATE " by that marked " NOT TO OPERATE." If the relay armature still pulls over readjust the bias screw until it just falls back.

(*d*) Repeat the above operations until the relay armature pulls over with the resistance marked "OPERATE" in circuit and does not with the resistance marked " NOT TO OPERATE."

If a milliammeter is available the following test may be applied :—

Adjust the bias on the armature by means of the bias screw until the relay operates with a current of 1·2 milliamps but not with a current of 0·9 milliamps applied to the line terminals.

The contacts of the relay which are adjusted initially should not be disturbed unless it is absolutely necessary when the following directions should be carried out :—

(*e*) Remove the line unit by unscrewing the four captive screws and drawing it forward.

(*f*) Release the two 6 B.A. cheese-headed locking screws on the top of the relay.

(*g*) Unscrew the fixed contact and back stop several turns.

(*h*) Apply about 4·5 to 6 volts to the two captive screws at the top when the armature should pull over on to the pole faces. The fixed contact must be withdrawn sufficiently so as not to make contact with the armature.

(*i*) Apply 3 to 4·5 volts to the two captive screws at the bottom. Screw up the contact screw until the lamp just lights, then screw up 1/8 turn (45°) more and tighten the locking screw. If the armature buzzes reverse the lamp battery.

(*j*) By means of a feeler gauge adjust the back stop until the gap between it and the armature is 0·01 in., and then lock the back stop.

(*k*) Adjust the bias on the armature as described above.

(*l*) Apply the tests given in Sec. **3**, para. 3, ii above.

iii. *To adjust the auxiliary contacts on the " A " jacks.*— The auxiliary contacts on the " A" jack of a line unit are those which control the lamp circuit. The blades affected are the three nearest the relay and they should be adjusted as described below. *The adjustments should only be carried out by an instrument repairer or skilled mechanic.*

(*a*) Remove the line unit concerned by unscrewing the four captive screws and drawing it forward.

(*b*) Adjust the springs so that the centre spring makes contact with that farthest away from the relay.

(*c*) Insert a plug in the jack and adjust, if necessary, so that the centre spring makes contact with the spring nearest the relay.

(*d*) When the tip of the plug has passed over the ring contact "V" of the jack but not over the tip contact "V" of the jack, the centre spring should not make contact with either of its adjacent springs.

iv. *To adjust the night bell.*—

(*a*) Remove the securing screw from the top of the bell and lift off the gong.

(*b*) Unscrew a few turns the adjusting screw which bears on the spring attached to the armature.

(*c*) Connect two Cells, Dry, X, Mk. II, or Cells, Inert, S, Mk. I, in series across the terminals of the bell.

(*d*) Screw in the adjusting screw until the armature vibrates vigorously.

v. *To adjust the night alarm relay.*—The following operations must be performed with new cells. Incorrect adjustments will result from the use of old or partly used cells.

(*a*) Remove the battery box and disconnect one cell, so that only two are in circuit.

(*b*) Replace the battery box and connect in circuit again,

(*c*) Remove the two cheese-headed screws on the front panel of the common apparatus unit. These screws secure the unit in place.

(*d*) Draw out the unit carefully until access to the night alarm relay can be obtained.

(*e*) Connect up the night alarm circuit as given in Sec. **3**, para. 2, iv, above.

(*f*) Pull out the "BATTERY PULL ON" switch.

(*g*) Carefully pull over the armature on one of the line units to make contact with the contact screw.

(*h*) Adjust the bias screw on the night alarm relay until the armature just pulls over.

The night alarm relay is now in adjustment.

(*i*) Switch off the battery and disconnect the night bell.

(*j*) Remove the battery box and re-connect the third cell in series with the other two.

(*k*) Replace the battery box and connect the battery in the switchboard circuit.

(*l*) Perform the night alarm relay test as given in Sec. **3** para, 3, x, above.

(*m*) If the test is satisfactory replace the common apparatus unit and the two cheese-headed screws. If the test is unsatisfactory repeat operations (*a*) to (*l*), above.

The contacts of the night alarm relay which are adjusted initially should not be disturbed unless it is absolutely necessary when the following directions should be carried out :—

(*n*) Withdraw the common apparatus unit, as in (*c*) and (*d*) above, to obtain access to the night alarm relay.

(*o*) Set up the night alarm circuit by first removing the night bell from the rear lower lid of the switchboard and then connecting the lugs of the night bell connector to the terminals on the base of the bell. Insert the plug on the other end of the connector in the " NIGHT ALARM " jack.

(*p*) Release the two 6 B.A. cheese-headed locking screws on the top of the relay.

(*q*) Unscrew the fixed contact and back stop several turns.

(*r*) Pull out the " BATTERY PULL ON " switch.

(*s*) Carefully pull over the armature on one of the line unit relays to make contact with the contact screw. If the relay is correctly adjusted it will remain holding.

(*t*) Carefully pull over the armature of the night alarm relay. The fixed contact must be withdrawn sufficiently so as not to make contact with the armature.

(*u*) Screw up the contact screw of the night alarm relay until the bell rings, then screw up 1/8 turn (45°) more and tighten the locking screw.

(*v*) By means of a feeler gauge adjust the back stop until the gap between it and the armature is 0·01 in., and then lock the back stop.

(*w*) Adjust the bias on the armature as described above.

(*x*) Take a spare cord and holding the tip of one plug against the right-hand bottom screw head of a line unit, touch the case of the indicator lamp on the unit with the tip of the other. The lamp will light and the night bell should ring.

(*y*) Replace the common apparatus unit in position.

vi. *To adjust the buzzer.*—

(*a*) Loosen the collars marked " LOCK " by unscrewing them.

(*b*) Screw out the contact screws a few turns.

(*c*) Press the " SPEAK-BUZZ " key switch to " BUZZ."

(*d*) Keeping this key at " BUZZ " screw in the left-hand adjusting knob until a buzz is heard and adjust until the loudest note is heard irrespective of quality or pitch.

(*e*) Lock the knob.

(*f*) Adjust the right-hand contact knob until a clear and fairly high note is obtained.

(*g*) Lock the knob.

(*h*) Check the adjustments by operating the " SPEAK-BUZZ " key switch and re-adjust if necessary.

NOTES.—1. Neither the maximum output nor the maximum efficiency is obtained from the buzzer when adjusted for the highest note.

2. No undue force must be used in locking the knobs, a quarter of a turn of the locking rings being sufficient to lock or release them. LIGHT PRESSURE ONLY IS REQUIRED TO LOCK.

The best quality of the note and the permanence of adjustment are achieved when the pitch is a little below the highest obtainable.

SPECIAL NOTE.—When adjusting the buzzer contacts care must be exercised not to force the contact screws " hard in " or the platinum contacts will be damaged and the buzzer put out of action.

4. Working instructions for Switchboards U.C. 6-line

1. *Preliminary.*—If possible the switchboard should be set up on a table or other support off the ground.

Superposing is carried out by means of the Superposing Units (One Transformer) full directions for its use being given in Signal Training, Vol. III, Pamphlet No. 20, " Superposing Units (One Transformer)."

In setting up the switchboard carry out the instructions given in Sec. 3, Working instructions for Switchboards U.C. 10-line, para. 1, xii to xxvi.

Normally no weights are issued with the 6-line board and the cords may be laid out in front of the switchboard, or threaded through the holes in the cord shelf in the same way as weighted cords. Weights are supplied when specially called for and the cords are then arranged as for the 10-line board.

2. *Operating the switchboard.*—The method of operating the switchboard is the same as for Switchboards U.C. 10-line.

The night bell is packed in the accessory box instead of in the switchboard case as in the Switchboard U.C. 10-line.

3. *Tests and adjustments.*—These are the same as for Switchboards U.C. 10-line.

5. Maintenance and repair

1. *General.*—The apparatus should be kept clean and dry. Any parts which are secured by screws and which require replacement can be renewed if spares are available, but riveted parts will have to be repaired by Ordnance Workshops.

The cases of the switchboards, accessory box and superposing unit should be examined for broken or missing catches, hinges, screws, etc.

The cable forms in the interior of the cases should be examined for breaks.

See that the captive screws, which hold the operator's unit and line units in position, are tight, as these screws, in addition to holding the panels form part of the electrical circuit of the switchboard.

2. *The battery box.*—It is essential that the battery compartment be kept clean and any corrosion should be removed from the batteries. This is of importance since, if battery corrosion continues for any length of time, difficulty may be experienced in removing the old cells for replacement purposes.

3. *The buzzer.*—Buzzer failure should be overcome by replacement by another buzzer, if possible, before any attempt is made at repairs.

The buzzer is removed as follows :—

i. Remove the small bracket on the side of the case near the buzzer by releasing the holding nuts and screws.

ii. Remove the four 4 B.A. nuts which hold the buzzer in position.

iii. Carefully draw the buzzer forward by the edges of the face plate.

iv. Unlock the adjusting knobs by unscrewing the locking collars a few turns.

v. Unscrew and withdraw the adjusting knobs and locking collars.

vi. Unscrew the two 4 B.A. countersunk screws and remove the face plate.

The buzzer is now ready for replacement or repairs. Small parts of the buzzer which are attached by screws (not riveted) such as the bakelised cover plate, adjusting and locking knobs, armature springs, etc., may be replaced if necessary.

Any coil replacements will have to be carried out by Ordnance Workshops.

The contacts of the buzzer, if they have become pitted or dirty, may be cleaned with a contact file or on an oilstone.

It is essential that the surfaces of the contacts be perfectly flat and if no suitable tools are available then the contacts should be left for the attention of Ordnance Workshops.

The threads of the adjusting knobs and locking collars should be kept free from grit and should be cleaned with an oily rag if they have become stiff or gritty.

4. *The operator's microphone and receiver.*—

i. Transmitter, Breast, No. 1, and Receivers, Headgear C.L.R., Double, Mk. VI.

Access to the microphone capsule for the purpose of replacement is obtained as follows :—

(*a*) Unscrew and remove the five countersunk screws on the back of the breast plate. This will release the microphone housing.

(*b*) Pull back the back contact strip which is pivoted, and swing it clear of the microphone caspule.

(*c*) Lift the microphone capsule clear of the front contact spring and remove it from the microphone housing.

The capsule may now be replaced and the transmitter reassembled, the operations being in the reverse order to those described above.

The ball and socket joint, which takes the mouthpiece, should be kept free from grit and dirt.

The spring which holds the ball in position may be replaced if necessary. Access to it is obtained by unscrewing the front of the microphone housing. Small parts of the operator's transmitter and headphones which are attached by screws (not riveted) may be replaced if necessary.

Any coil replacements will have to be carried out by Ordnance Workshops.

All screw terminals on the operator's transmitter and headphones should be tight and clean.

ii. *Microphone, Respirator No.* 2.—Access to the Microphone Capsule, Mk. V, of the Microphone, Respirator No. 2, is obtained by removing the four screws holding the two parts of the casing together. The capsule can then be lifted out and replaced. *Care should be taken to see that the rubber washer, which forms a gas-tight joint, is in place.* Small parts of the microphone which are attached by screws (not riveted) may be replaced if necessary.

iii. *Telephone, Hand, No.* 2.—The microphone capsule, (Microphone, Capsule, Mk. IV) can be removed and replaced by first removing the cover. This cover can be removed in the following manner, no force being required :—

Press a blunt instrument into the small hole in the top side of the cover and, keeping it pressed down, turn the cover in an anti-clockwise direction when it will come away readily.

IMPORTANT.—No attempt should be made to remove the cover by *unscrewing*.

Replace the cover as follows :—

Place and press on the cover of the microphone housing so that when turned clockwise through about 30 degrees it clicks into its correct attitude with respect to the body of the instrument. When in this position the small hole in the cap will point along the handle towards the earpiece.

Small parts of the handset which are attached by screws (not riveted) such as the flat contact springs of the microphone may be replaced if necessary. Any coil replacements will have to be carried out by Ordnance Workshops.

All screw terminals inside the handset should be tight and clean.

5. *Removal of units for maintenance and repair of components.*

i. *Line unit.*—Unscrew the four captive screws (two at the top and two at the bottom) which hold the unit in place and remove the unit by drawing it forward.

ii. *Operator's unit.*—

(*a*) Remove the first line unit as described in sub-para. i, above.

(*b*) Unscrew the four captive screws (two at the top and two at the bottom) which hold the operator's unit in position.

(*c*) Remove the unit by drawing it forward. The operator's unit is attached by cable form to the switchboard case so that it cannot be withdrawn very far. If it is required to remove the operator's unit completely, the cable form connections must be unsoldered.

iii. *The common apparatus unit.*—

(*a*) Remove the small bracket at the right-hand side of the switchboard case near the buzzer, by unscrewing the holding screws and nuts.

(*b*) Remove the two 4 B.A. cheese-headed screws on the front panel and draw the common apparatus unit forward. The unit is attached by cable form to the switchboard case so that it cannot be withdrawn very far. If it is required to remove the common apparatus unit completely, the cable form connections must be unsoldered.

6. *The magneto generator.*—Any parts of the magneto generator which are attached by screws may be removed and replaced but riveted parts and burnt out or otherwise damaged coils should be left for the attention of Ordnance Workshops.

7. *The plugs, jacks, cords, switch keys and buzzer contact springs.*—Examine all plugs, jacks and sockets ; they should be kept clean to ensure good contact.

Examine the jacks, switch keys and buzzer contact springs for broken or bent springs.

The leads and cords should also be examined for breaks and wear, particularly at the points where they join connecting elements such as plugs, and where friction takes place between cords and pulley weights.

8. *The lamps.*—A faulty bulb should be replaced as follows :—

i. Remove the cover which is held by bayonet slots and pull the bulb forward with its thick metal collar.

ii. Unscrew the bulb from the thick collar and replace by a new one.

When replacing the front cover see that the number on the window is the right way up.

9. *The relays.*—Relay failure should be overcome by replacement by another relay if possible before any attempt is made at repairs.

Small parts of the relay which are attached by screws (not riveted) may be replaced if spares are available.

Any coil replacements will have to be carried out by Ordnance Workshops.

If the contact of a relay becomes dirty it should be removed and cleaned with great care by means of a burnishing tool. This operation should only be performed by an instrument repairer.

10. *The night bell.*—Any parts of the bell which are attached by screws may be removed and replaced, but riveted parts and burnt out or otherwise damaged coils should be left for the attention of Ordnance Workshops.

11. *The test resistances* (*Resistances, Test*).—Burnt out or otherwise damaged test resistances, and broken holding clips should be left for the attention of Ordnance Workshops.

12. *The Superposing Unit* (*Three Transformer*).—The U-links and U-link sockets and terminals should be kept clean.

Examine the panel to see that no U-links are missing.

See that the jumpering connector is in its place on the panel. The plugs should be inserted in the dummy sockets when the connector is not in use.

A faulty transformer should be replaced if spares are available, coil repairs being performed by Ordnance Workshops.

Access to the transformers may be obtained as follows :—

i. Remove the three 2 B.A. cheese-headed screws which hold the panel in position.

ii. Lift out the panel by the terminals until the wires which pass through the ebonite clamp are taut.

iii. Slacken off the lock nuts which hold the ebonite clamp.

iv. Draw the wires through the clamp and lift the panel clear.

Unsolder the cable form connections to the faulty transformer and remove the nuts and screws at the base. The transformer may then be lifted out.

APPENDIX I
LIST OF MAIN COMPONENTS
SWITCHBOARDS U.C. 10-LINE AND 6-LINE

Description	Reference			Value	Remarks and V.A.O.S. nomenclature
	Symbol	Figure	Plate		
(1)	(2)	(3)	(4)	(5)	(6)
		COMMON APPARATUS UNIT			
Buzzer..		1 and 6	V and VI		Buzzer T, Mk. I (Sec. Y).
Condenser	C_1	1, 5 and 6	VI	0·5 μF	Condenser P_5C (Sec. Y)
Magneto generator ..		1 and 7	V and VI		Generator B fitted with Generator B, Handle, No. 2 (Sec. Y).
" NIGHT ALARM " jack		1, 8 and 10	V and VI		Jack No. 500A (Sec. Y).
Night alarm relay ..	REL. 2	1 and 10	IV, VI and XVI		Switchboard U.C. Relay Alarm (Sec. Y).
Resistance	R_1	1, 5 and 6	VI	400 ohms	Resistor No. 2B, ½ watt 400 ohms or Resistor No. 3B, ½ watt 400 ohms (Sec. Z).
Switches :					
" BATTERY PULL ON " switch	S_2	1, 8 and 10	V and VI		Switchboards U.C. Common Apparatus Unit : Switches, Battery.
" SPEAK-BUZZ " key switch	S_1	1, 5 and 8	V and VI		Switches, Speak/ Buzz (Sec. Y).
		LINE UNIT			
NOTE.—The following components comprise one line unit :—					
Indicator lamp ..		2, 3, 4 and 10	VII and VIII		
Bulb			VIII		Bulbs, 3·5 volt K* (Sec. W2).
Holder			VIII		Switchboards U.C., Line Unit Lamp-holders (Sec. Y).
Jacks—					
" A " jack		2, 3, 4, 5, 7, 8, 9 and 10	VII and VIII		Jack No. 800A (Sec. Y).
" B " jack		2 and 9	VII and VIII		Jack No. 500A (Sec. Y).

* In later issues of Switchboards U.C. 10-line and 6-line this bulb will be replaced by one having a higher voltage rating and longer life.

APPENDIX I—*continued*

Description	Reference			Value	Remarks and V.A.O.S. nomenclature
	Symbol	Figure	Plate		
(1)	(2)	(3)	(4)	(5)	(6)
		LINE UNIT—*continued*			
Rectifier	RECT. 1	2, 3, 4 and 10	VII		Rectifier, Metal 4/4/1B (Sec. Z).
Relay	REL. 1	2, 3, 4 and 10	VII		Switchboard U.C. Relay Line (Sec. Y).
		OPERATOR'S UNIT			
Condenser	C_2	1, 5 and 6	IX	250 μF	Condenser 250 A (Electrolytic condenser 12V, D.C. working) (Sec. Z).
" Crash limiter " ..	X_1	1 and 5	IX		Rectifier, Metal, 2/2A (Sec. Z).
Four-point jack ..		1 and 5	IX		Jack No. 8 (Sec. Y).
Operator's jack ..		1, 5, 7, 8 and 9	IX		Jack No. 500A (Sec. Y).
Resistance	R_2	1, 5 and 6	IX	15 ohms	Resistor No. 2B, ½ watt 15 ohms or Resistor No. 3B, ½ watt 15 ohms (Sec. Z).
		MISCELLANEOUS			
Batteries			XVI	4·5 V.	3 Cells, Dry, X, Mk. II or 3 Cells, Inert, S, Mk. I (Sec. W2).
Battery box			III and XV		
Sling			I, II and XIII		Straps, Carrying, F (Sec. Y).
Test resistors			IV and XVI	1,960 ohms	Switchboards U.C. Resistance Test, 1,960 ohms (marked "OPERATE") (Sec. Y).
				2,960 ohms	Switchboards U.C. Resistance Test, 2,960 ohms (marked "NOT TO OPERATE") (Sec. Y).

APPENDIX I—*continued*

Description	Reference			Value	Remarks and V.A.O.S. nomenclature
	Symbol	Figure	Plate		
(4)	(2)	(3)	(4)	(5)	(6)
		Box Accessory			
Breast transmitter ..			III and X		Transmitter, Breast No. 1 (Sec. Y).
Handset			XII and XV		Telephone, Hand, No. 2 (Sec. Y).
Headphones			III		Receivers, Head-gear, C.L.R., double, Mk. VI (Sec. Y).
Night bell and connector		10	III, IV and XV		Switchboard U.C. Bell and Switchboard U.C. Bell Connector (Sec.Y).
Plugs, cords and pulley weights		5, 7, 8 and 9	III and XV		Plugs, No. 201(Red and Black), Cords, Switchboard, No. 242 (Red and Black), Pulley Weights, No. 16 (Sec. Y).
		Superposing Units (3-Transformer)			
Jumpering Connector			XVIII		Superposing Unit (3 - Transformer). Connector (Sec. Y)
Five-pair sockets ..		11	XIX		Frames, D. & P., 10 wire, Mk. I*, Socket-contacts 1/5 and 6/10 (Sec. Y).
Transformers ..		11	XIX	Primary and secondary 7 H each	Transformers, Superposing, No. 1 (Ratio 1 : 1) (Sec. Y).
		Superposing Units (1-Transformer)			
Transformer				Primary and secondary 7 H each	Transformers, Superposing, No. 1 (Ratio 1 : 1) (Sec. Y).
		Miscellaneous			
Earth pipes					Pipes, Earth, Mk. III (Sec. Y).
Transmitter for use with respirator			XI		Microphone, Respirator, No. 2, fitted to Respirator, Anti-gas (Sec. Y).

NOTES

(893/3231) Wt. 30457—8909 30M 4'40 H & S Ltd. Gp. 393

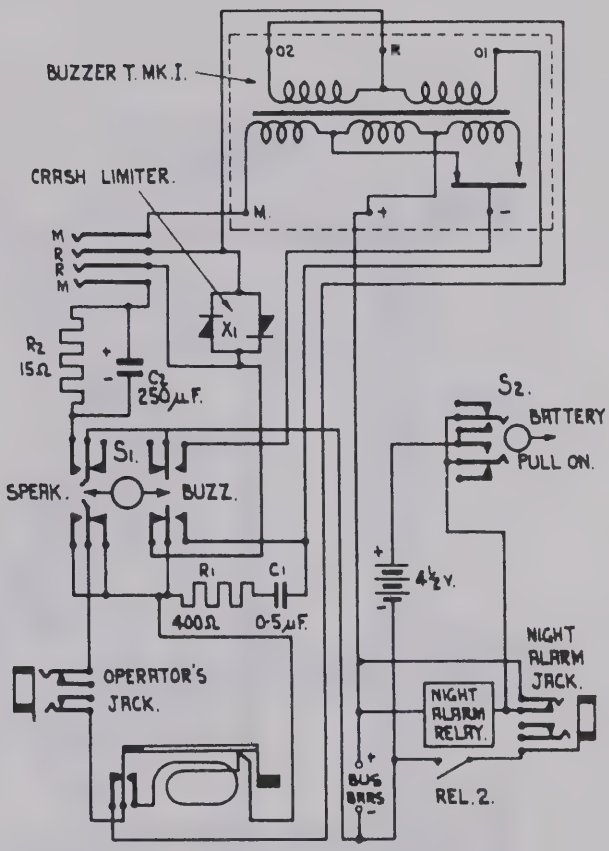


FIG. 1.

OPERATOR'S TELEPHONE CIRCUIT.

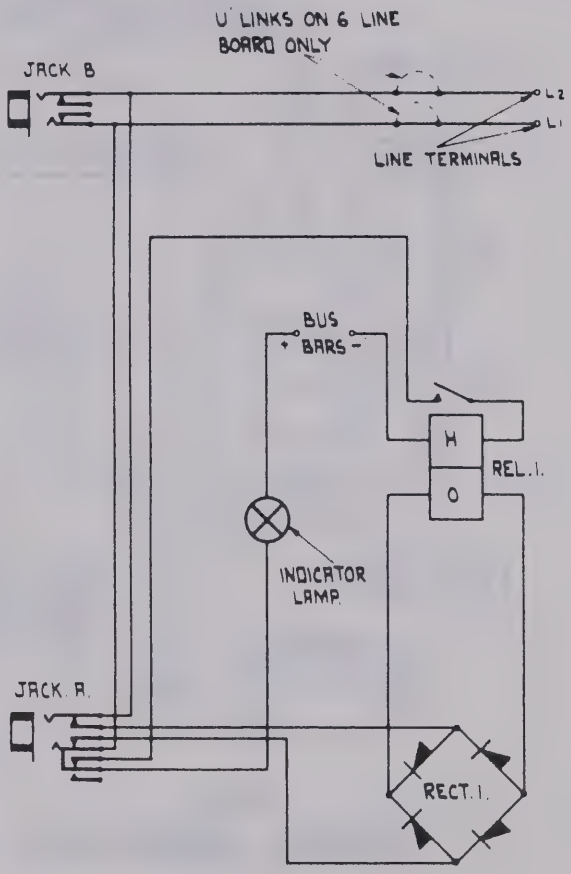


FIG. 2.

CIRCUIT OF LINE UNIT.

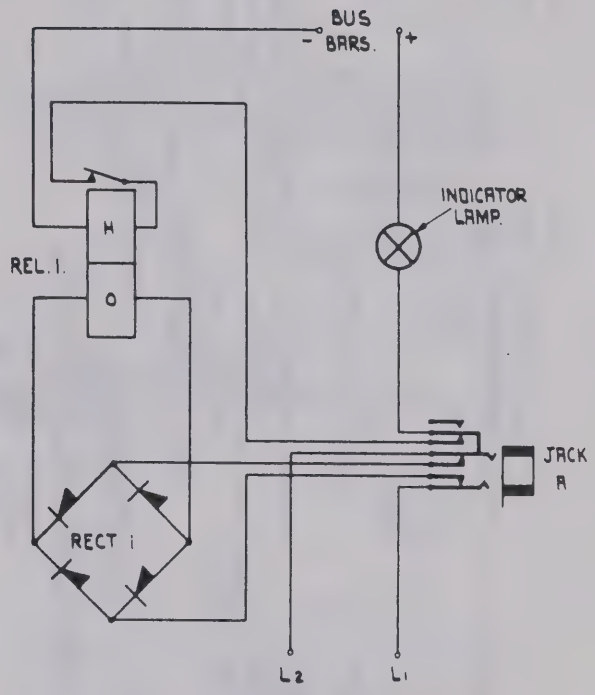


FIG. 3.

LINE UNIT

RECEIVING MAGNETO GENERATOR OR BUZZER CALLS.

(F.9692). Wt 39457. 30m. 12/39. Gp. 959. FOSH & CROSS Ltd

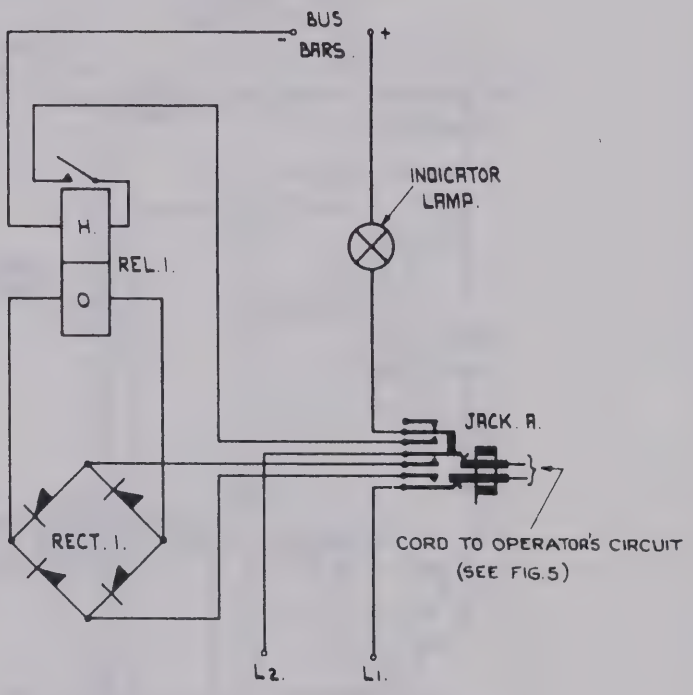


FIG. 4.

LINE UNIT

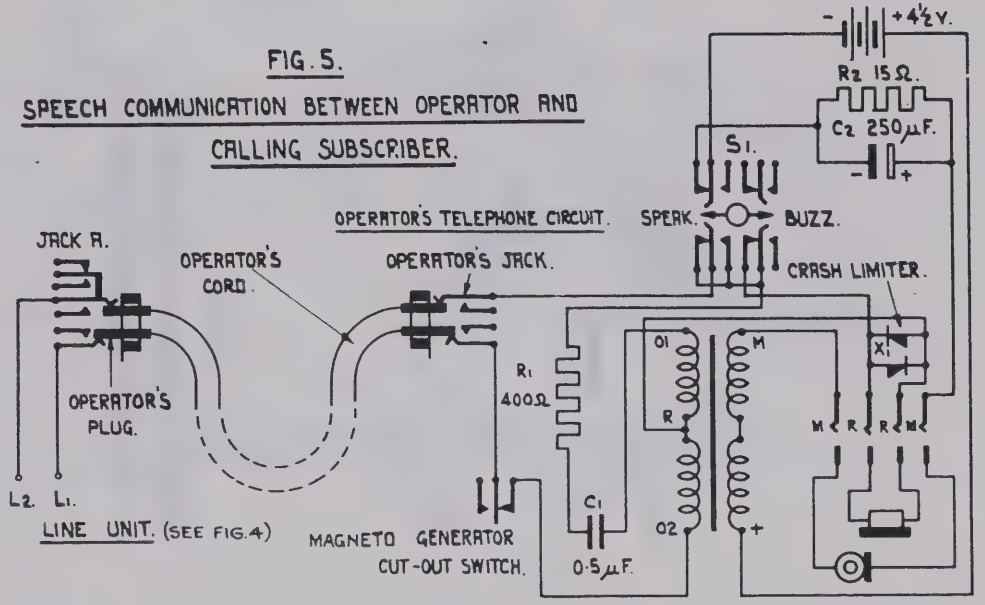
ANSWERING MAGNETO GENERATOR OR BUZZER CALLS.

(F.9692). FOSH & CROSS LTD

(F.9692). FOSH & CROSS LTD

FIG. 5.

SPEECH COMMUNICATION BETWEEN OPERATOR AND CALLING SUBSCRIBER.



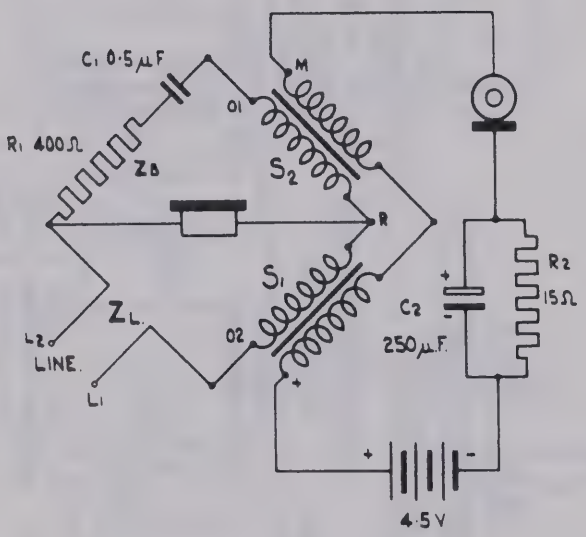


FIG. 6.

SPEECH COMMUNICATION SHOWING
ANTI-SIDE-TONE BRIDGE CIRCUIT.

(F. 9692). FOSH & CROSS LTD

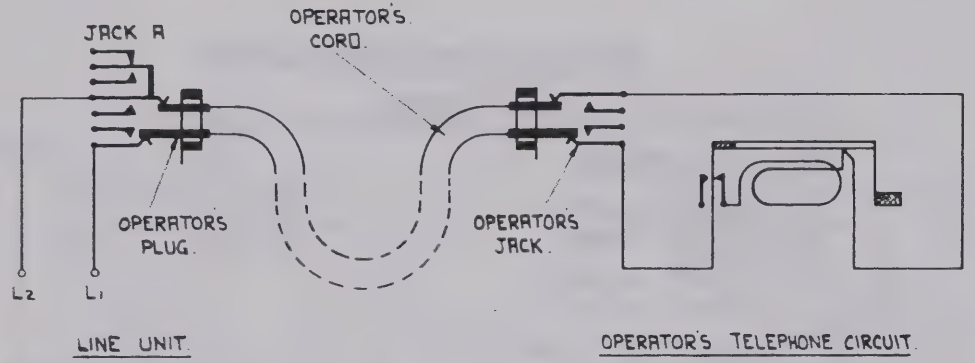


FIG. 7.

CALLING SUBSCRIBER BY MAGNETO GENERATOR.

(F.9692). FOSH & CROSS LTD

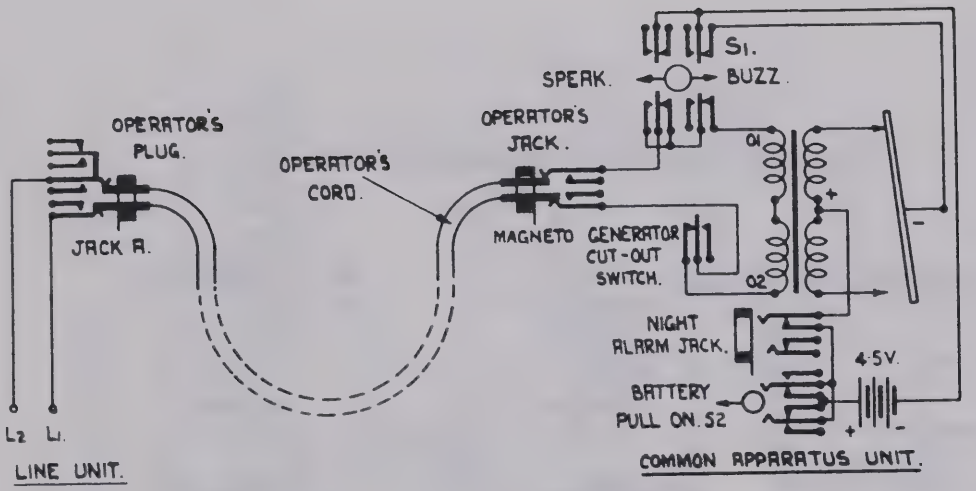


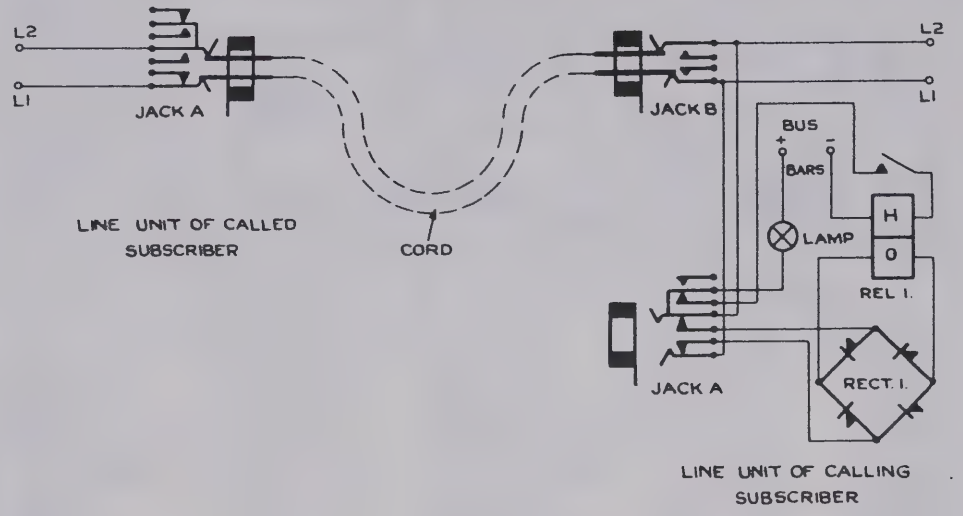
FIG. 8.

CALLING SUBSCRIBER BY BUZZER.

(F.9692). FOSH & CROSS LTD

FIG. 9

SPEECH COMMUNICATION BETWEEN TWO SUBSCRIBERS



(F.9692) FOSH & CROSS LTD

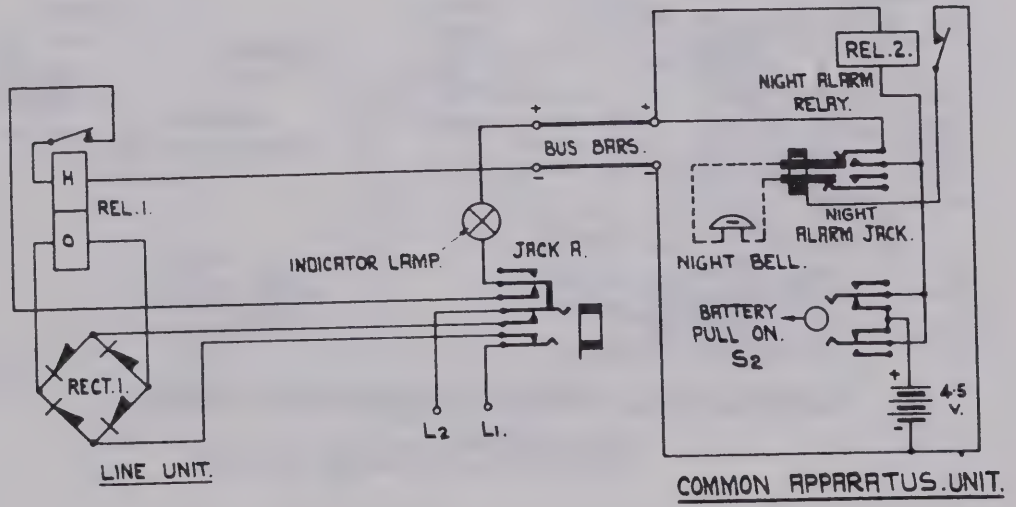


FIG. 10.

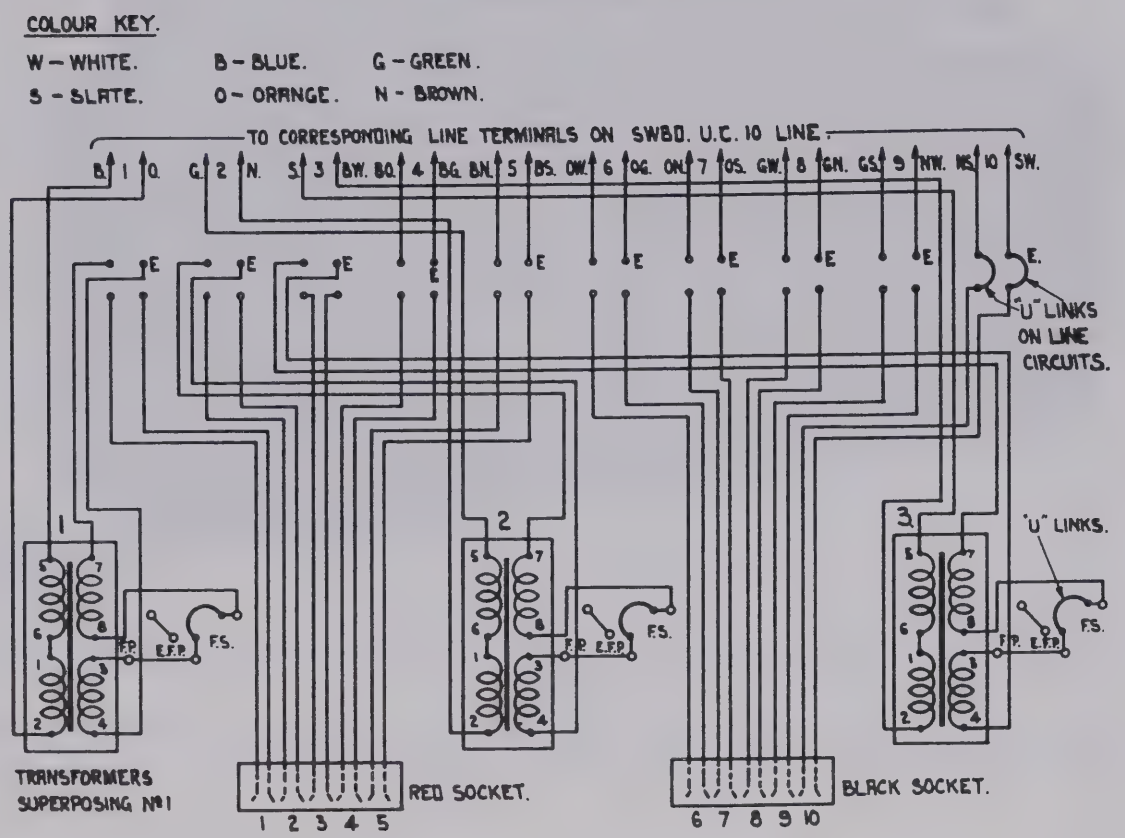
NIGHT ALARM CIRCUIT.

(F.9662). FOSH & CROSS LTD.

FIG. 11.

SUPERPOSING UNITS, (THREE TRANSFORMERS).

CIRCUIT DIAGRAM.


COLOUR KEY.
W – WHITE.
B – BLUE.
G – GREEN.
S – SLATE.
O – ORANGE.
N – BROWN.
TO CORRESPONDING LINE TERMINALS ON SWBD. U.C. 10 LINE.
B 1 O. G. 2 N. S. 3 BW. BO. 4 BG. BN. 5 BS. OW. 6 OG. ON. 7 OS. GW. 8 GN. GS. 9 NW. WS. 10 SW.
E.
"U" LINKS ON LINE CIRCUITS.
"U" LINKS.
F.P.
E.F.P.
F.S.
TRANSFORMERS SUPERPOSING No 1
RED SOCKET.
1 2 3 4 5
BLACK SOCKET.
6 7 8 9 10

(893/9281)9.

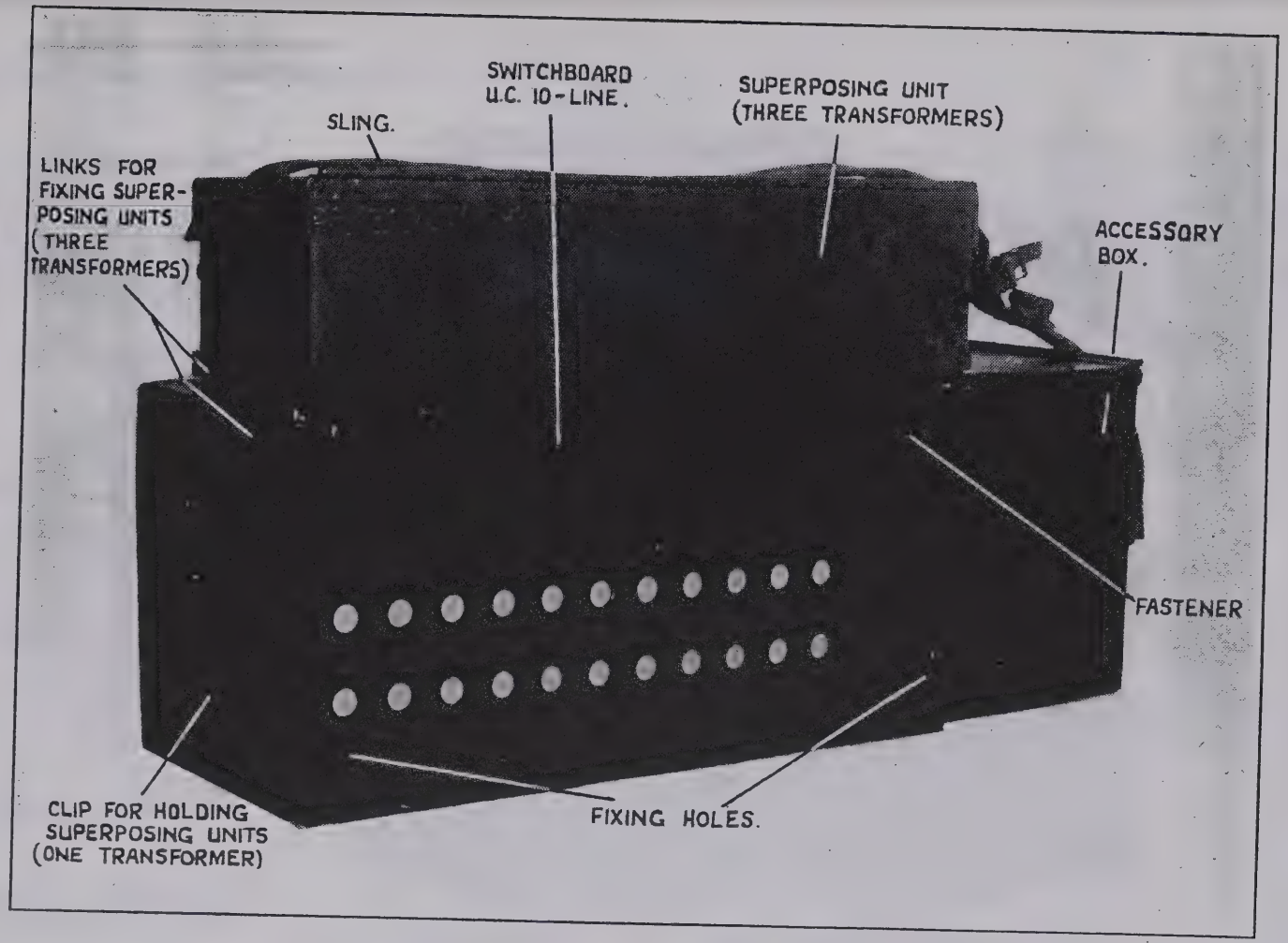


PLATE I

SWITCHBOARDS, U.C., 10-LINE WITH SUPERPOSING UNITS (THREE TRANSFORMER)—PACKED FOR TRANSPORT

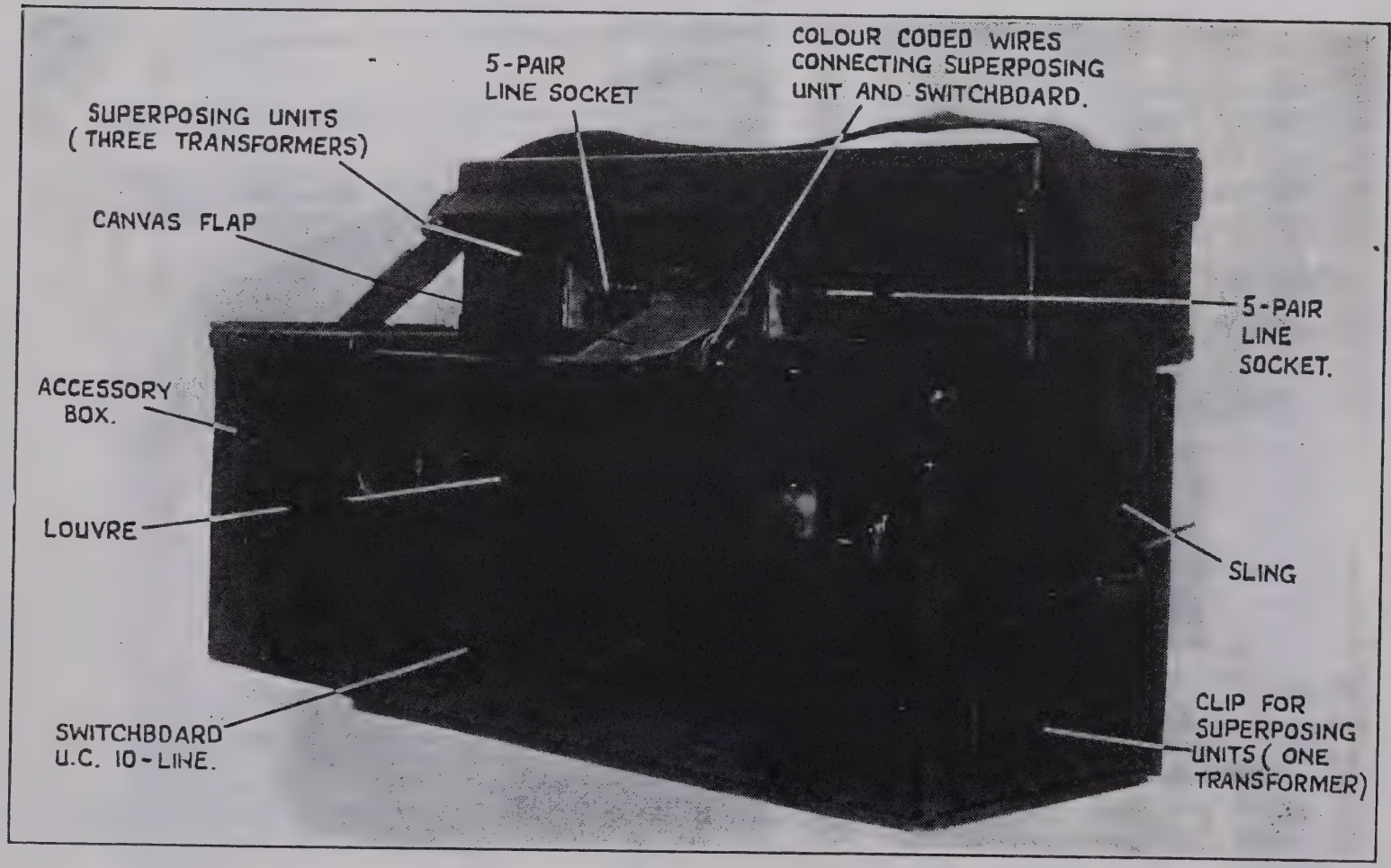


PLATE II

SWITCHBOARDS U.C. 10-LINE WITH SUPERPOSING UNITS (THREE TRANSFORMER)—REAR VIEW

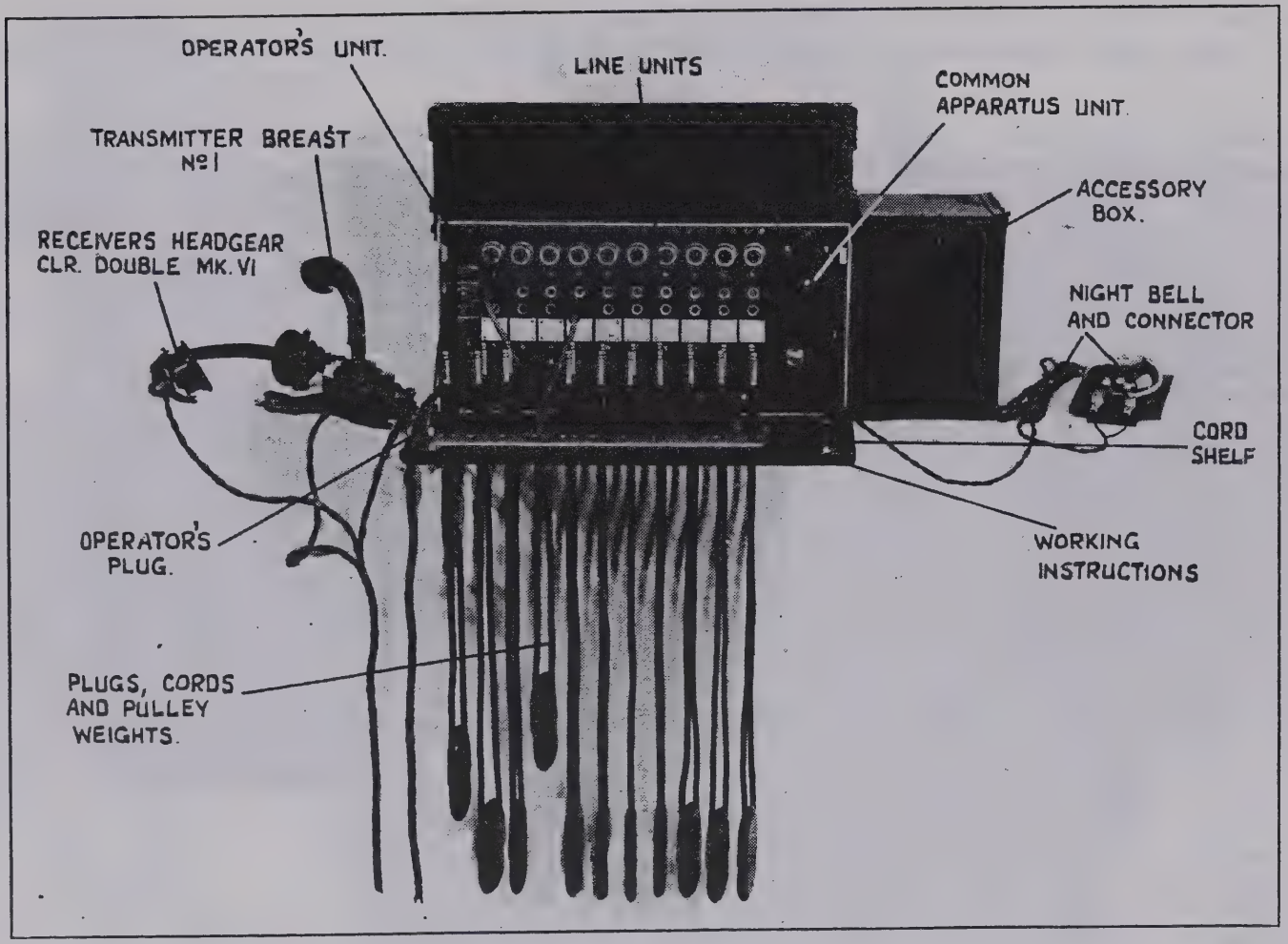


PLATE III

SWITCHBOARDS U.C. 10-LINE WITH SUPERPOSING UNITS (THREE TRANSFORMER)—
FRONT VIEW AS FOR WORK

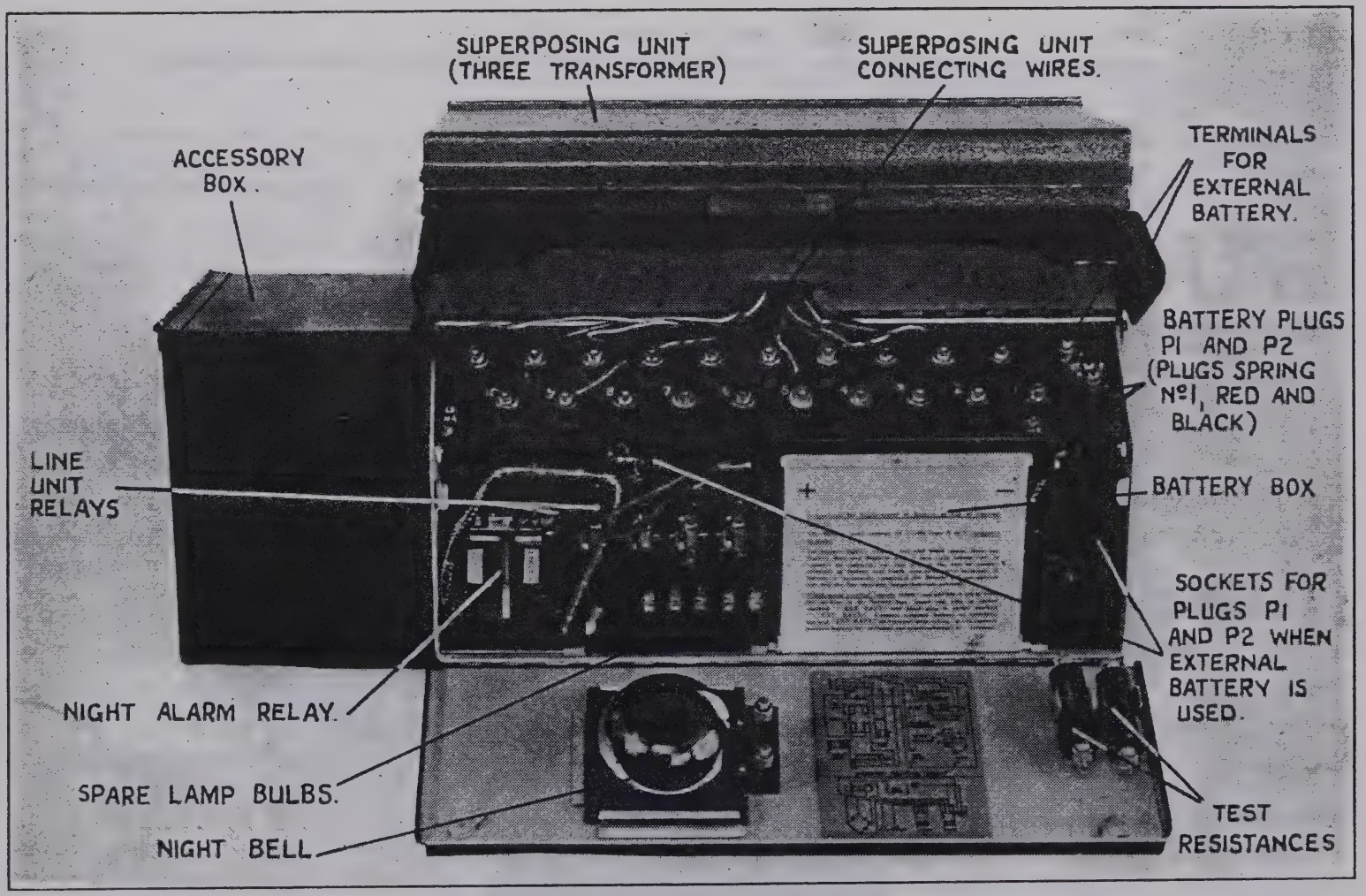


PLATE IV

SWITCHBOARDS U.C. 10-LINE WITH SUPERPOSING UNITS (THREE TRANSFORMER)—REAR VIEW OF INTERIOR OF SWITCHBOARD

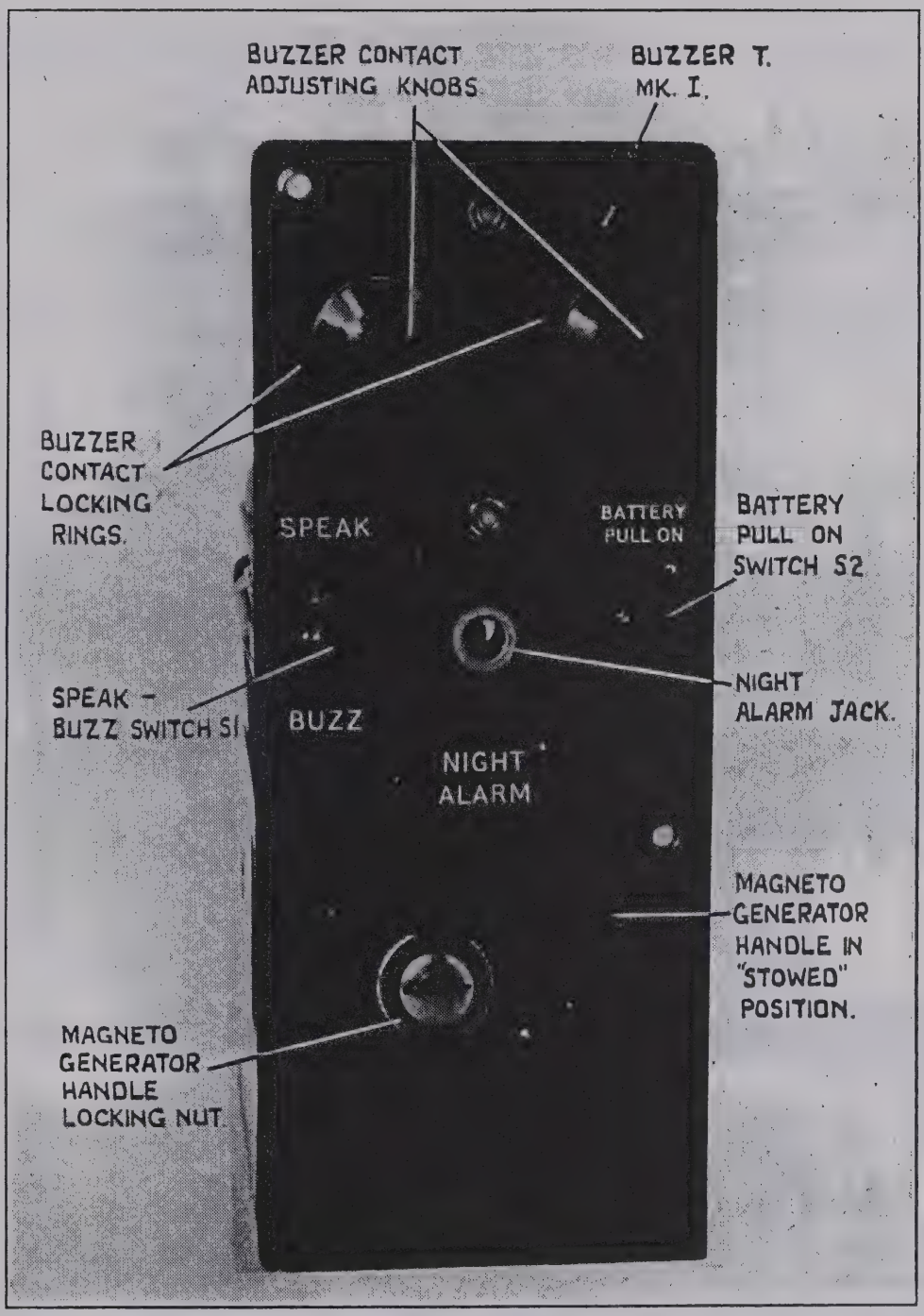


PLATE V

SWITCHBOARDS U.C. 10-LINE AND 6-LINE: COMMON APPARATUS UNIT—FRONT VIEW

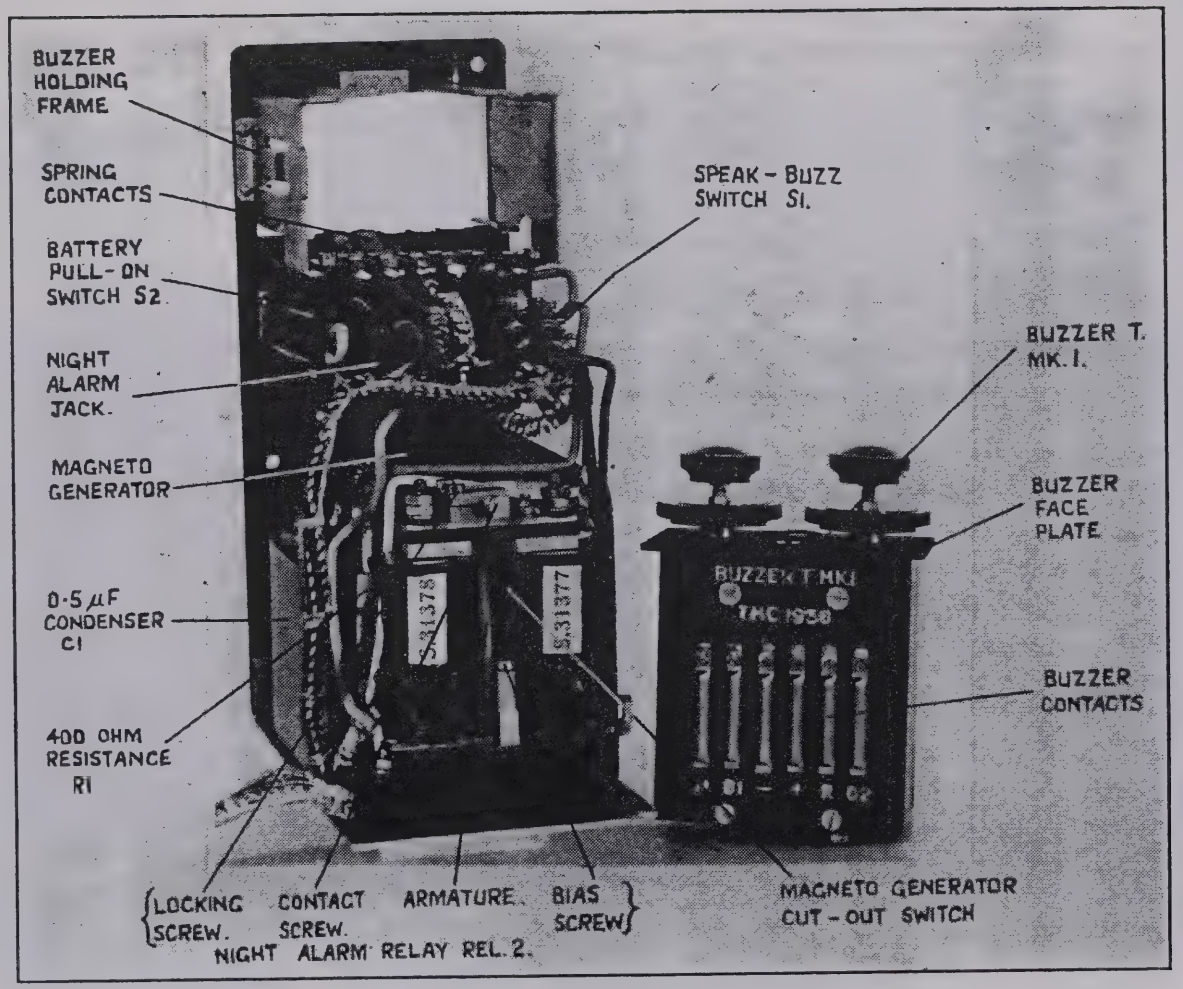


PLATE VI

SWITCHBOARDS U.C. 10-LINE AND 6-LINE: COMMON APPARATUS UNIT—REAR VIEW, BUZZER REMOVED

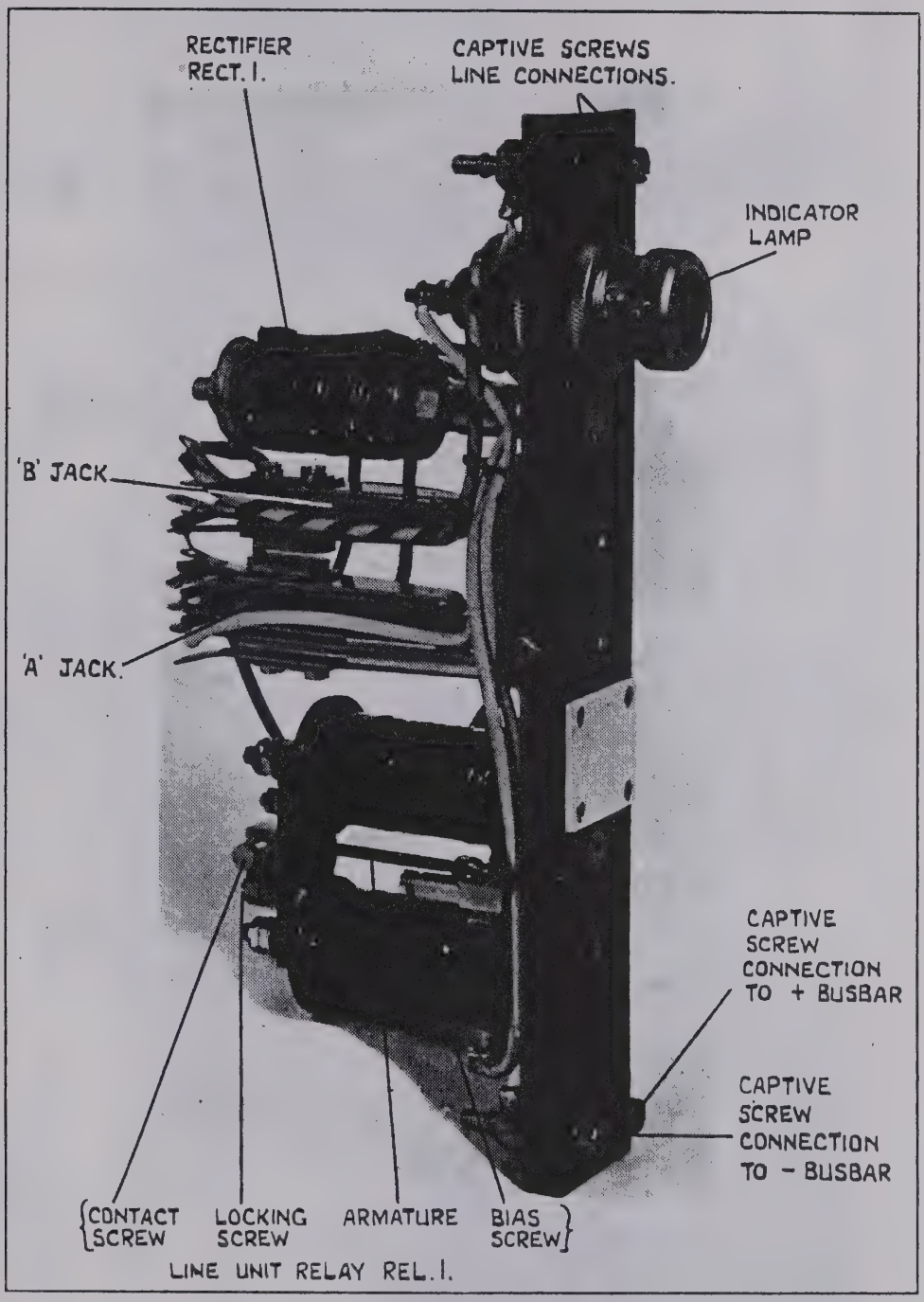


PLATE VII

SWITCHBOARDS U.C. 10-LINE AND 6-LINE: LINE UNIT—GENERAL VIEW

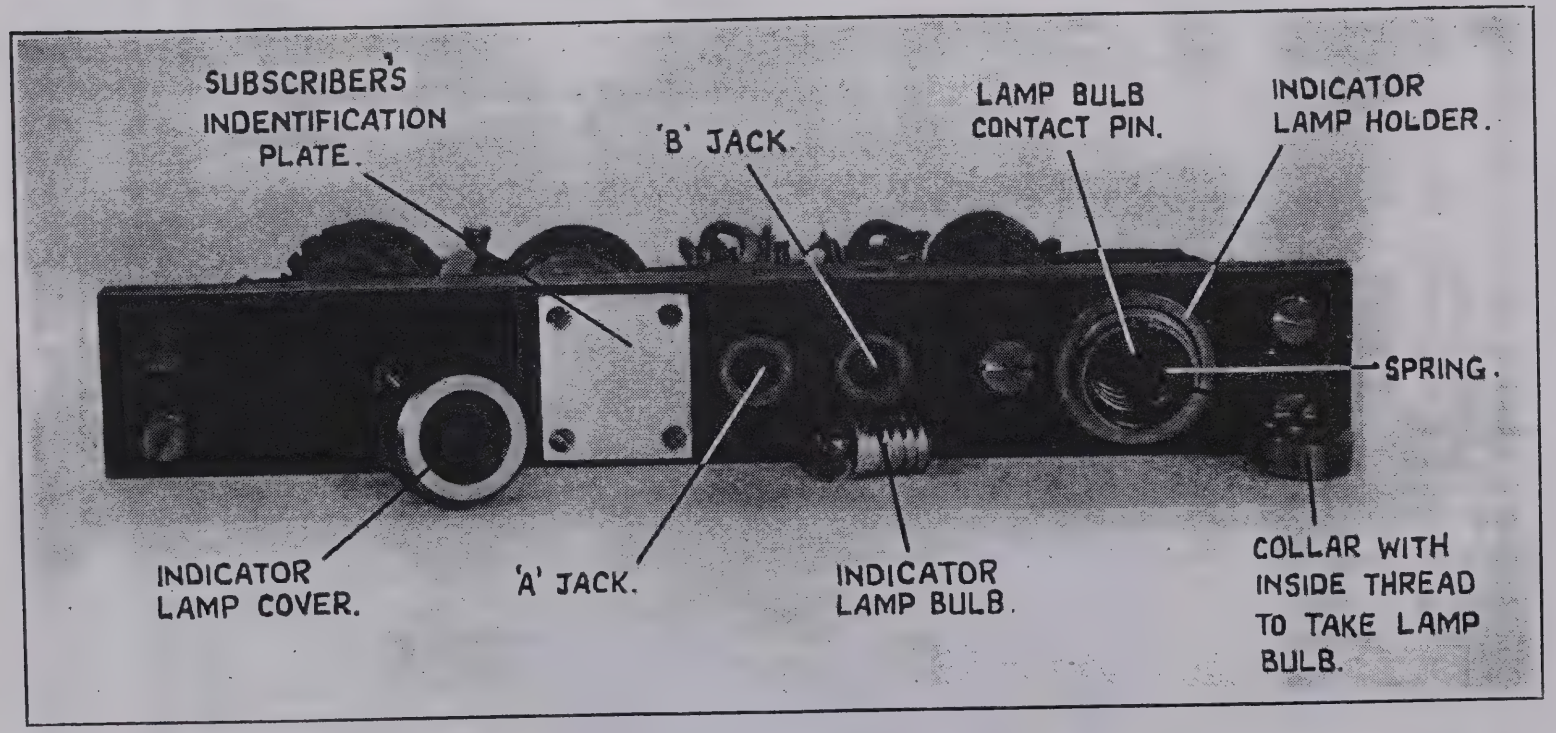


PLATE VIII

SWITCHBOARDS U.C. 10-LINE AND 6-LINE: LINE UNIT—FRONT VIEW, SHOWING INDICATOR PARTLY DISMANTLED

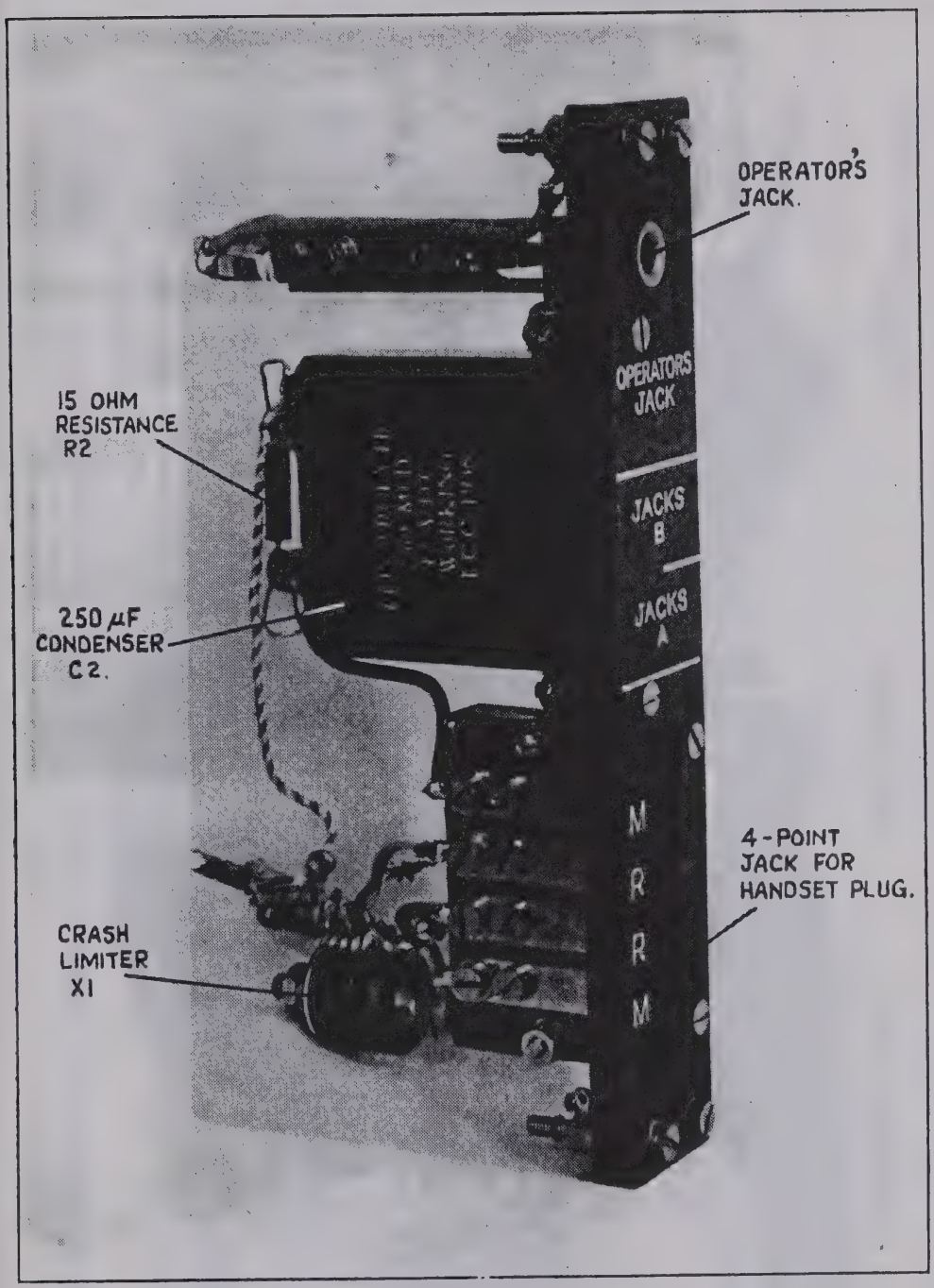


PLATE IX

SWITCHBOARDS U.C. 10-LINE AND 6-LINE: OPERATOR'S UNIT—GENERAL VIEW

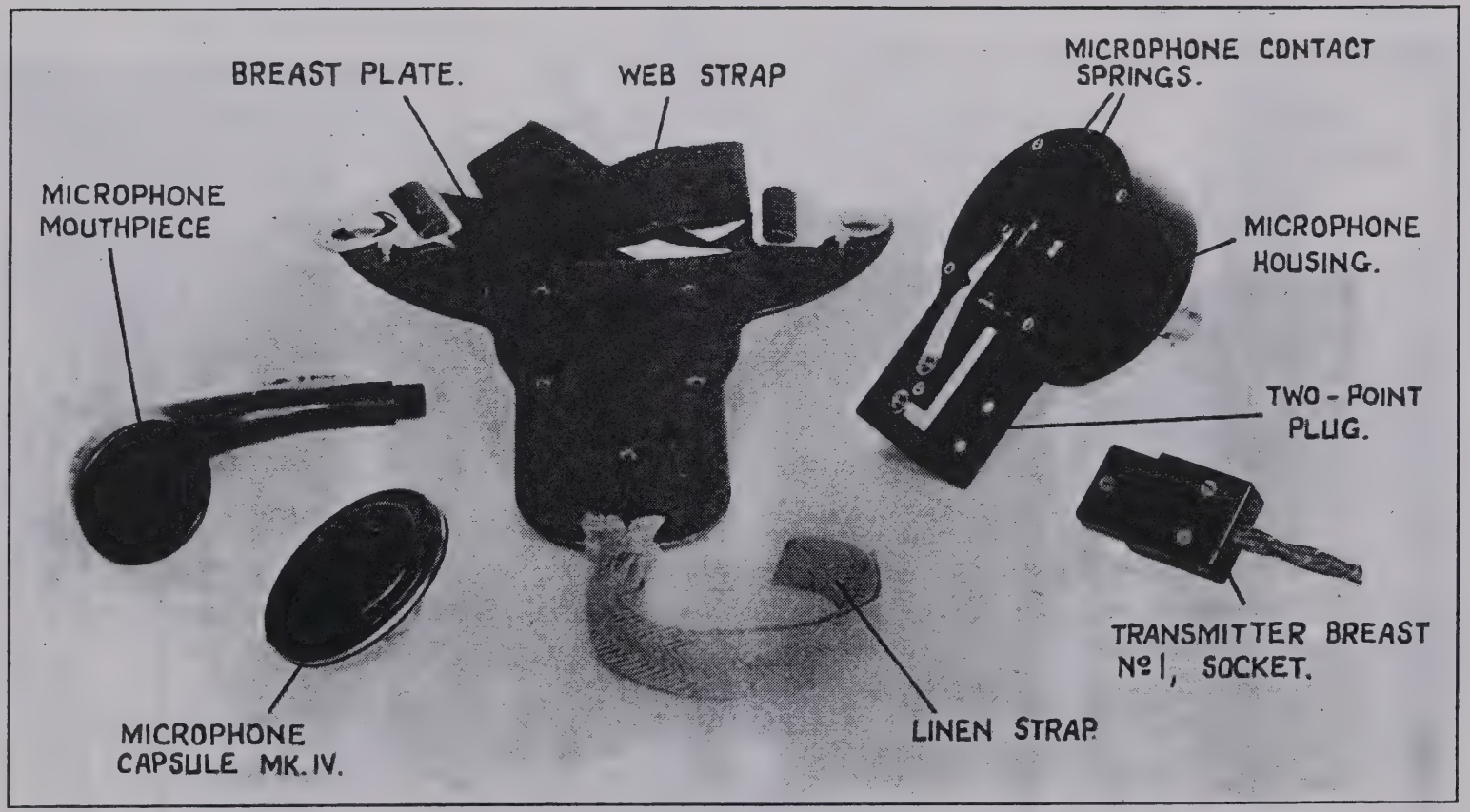


PLATE X

SWITCHBOARDS U.C. 10-LINE : OPERATOR'S BREAST TRANSMITTER—PARTLY DISMANTLED

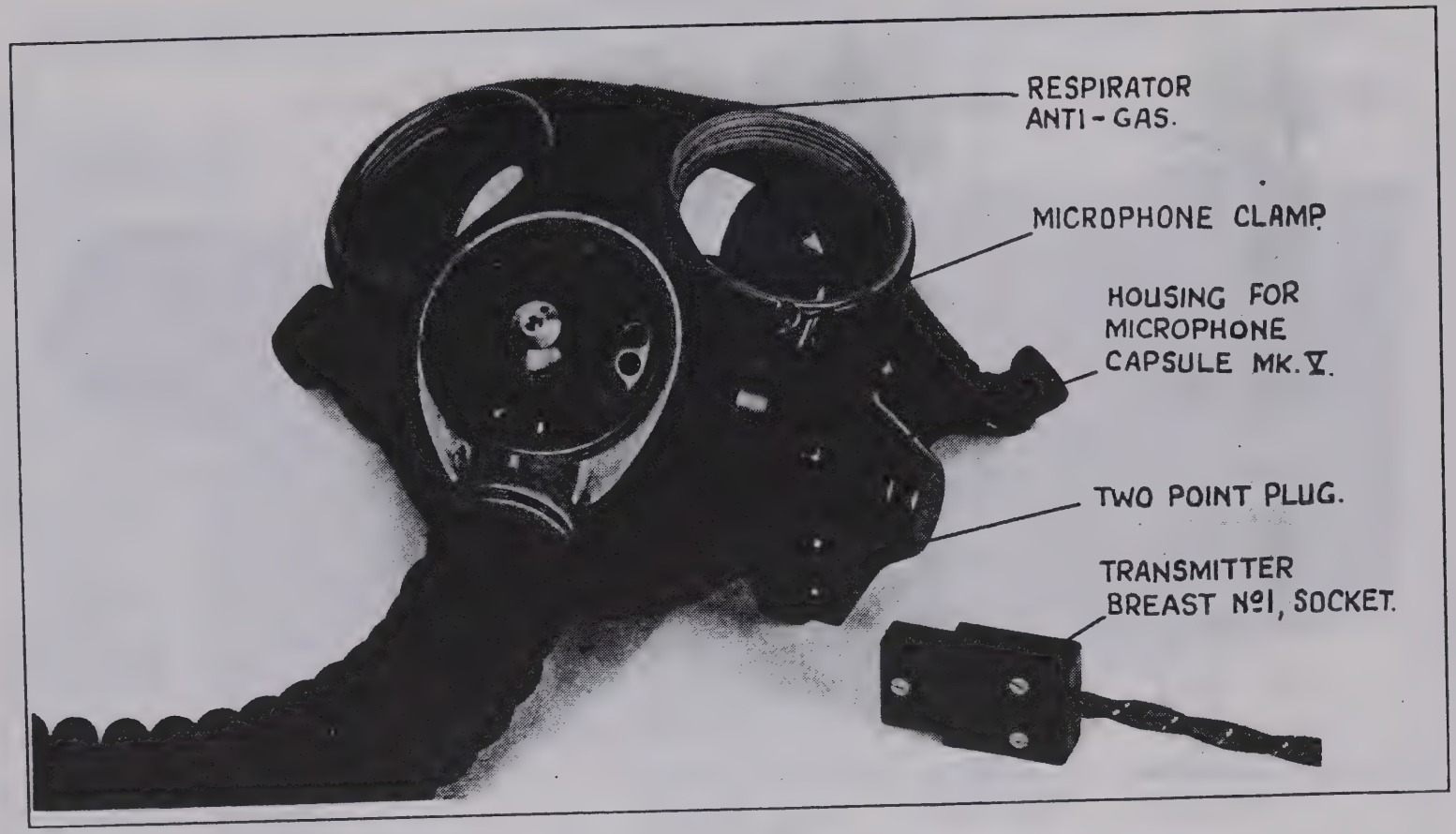


PLATE XI

MICROPHONE, RESPIRATOR, NO. 2—FITTED TO RESPIRATOR, ANTI-GAS, MK. V.

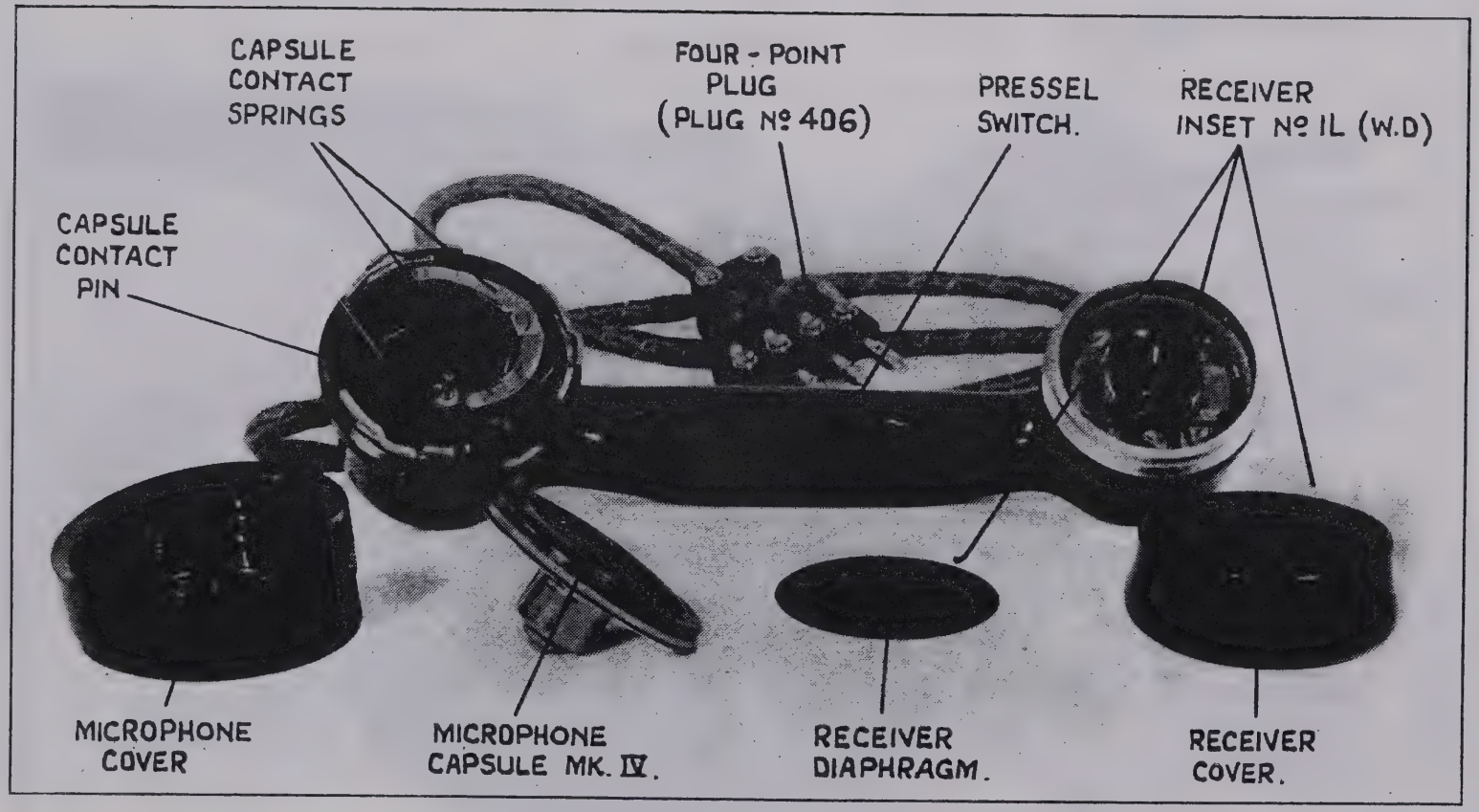


PLATE XII

SWITCHBOARDS U.C. 10-LINE AND 6-LINE : TELEPHONE, HAND, NO. 2, PARTLY DISMANTLED TO SHOW COMPONENT PARTS

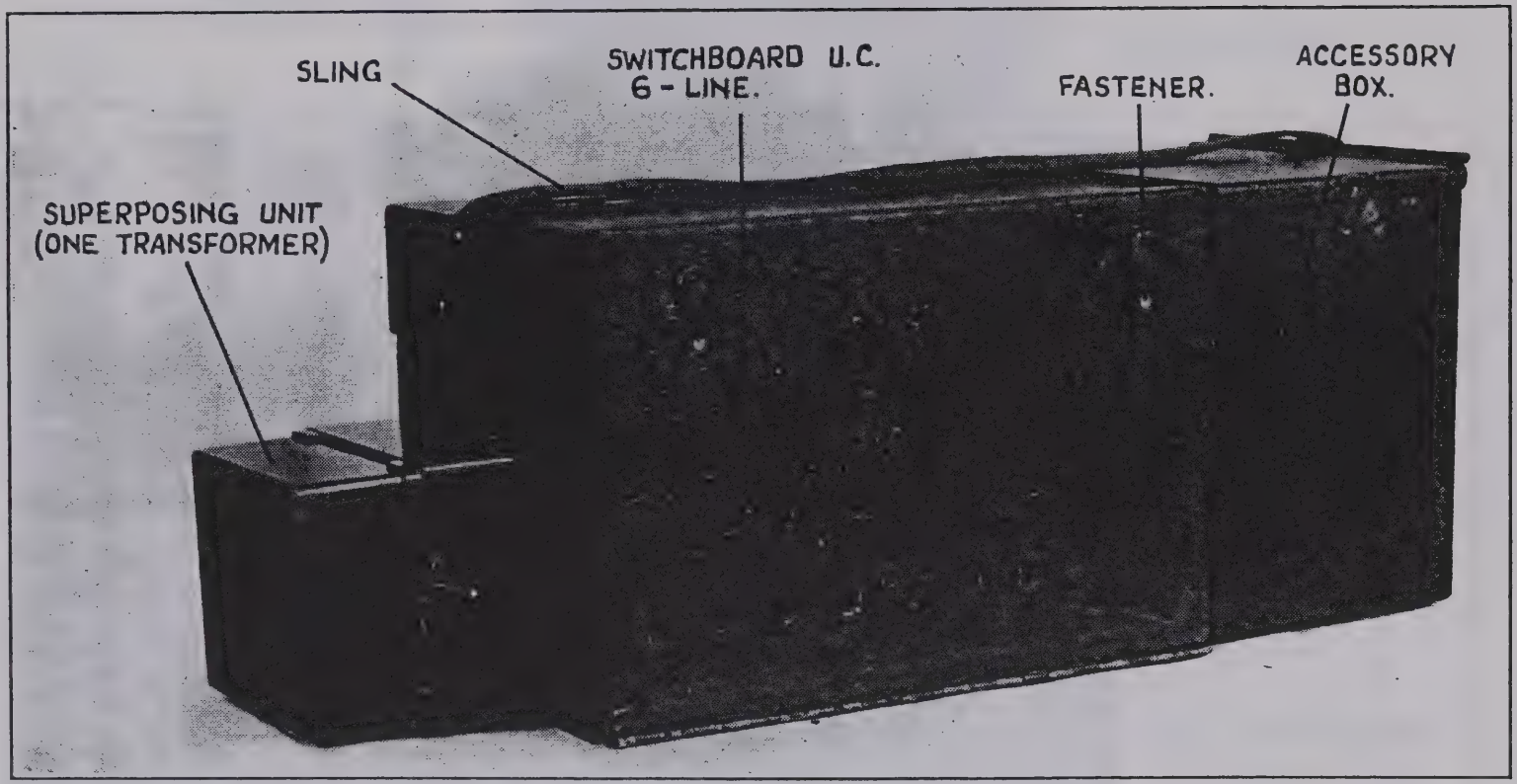


PLATE XIII

SWITCHBOARDS U.C. 6-LINE WITH SUPERPOSING UNITS (ONE TRANSFORMER)—
PACKED FOR TRANSPORT

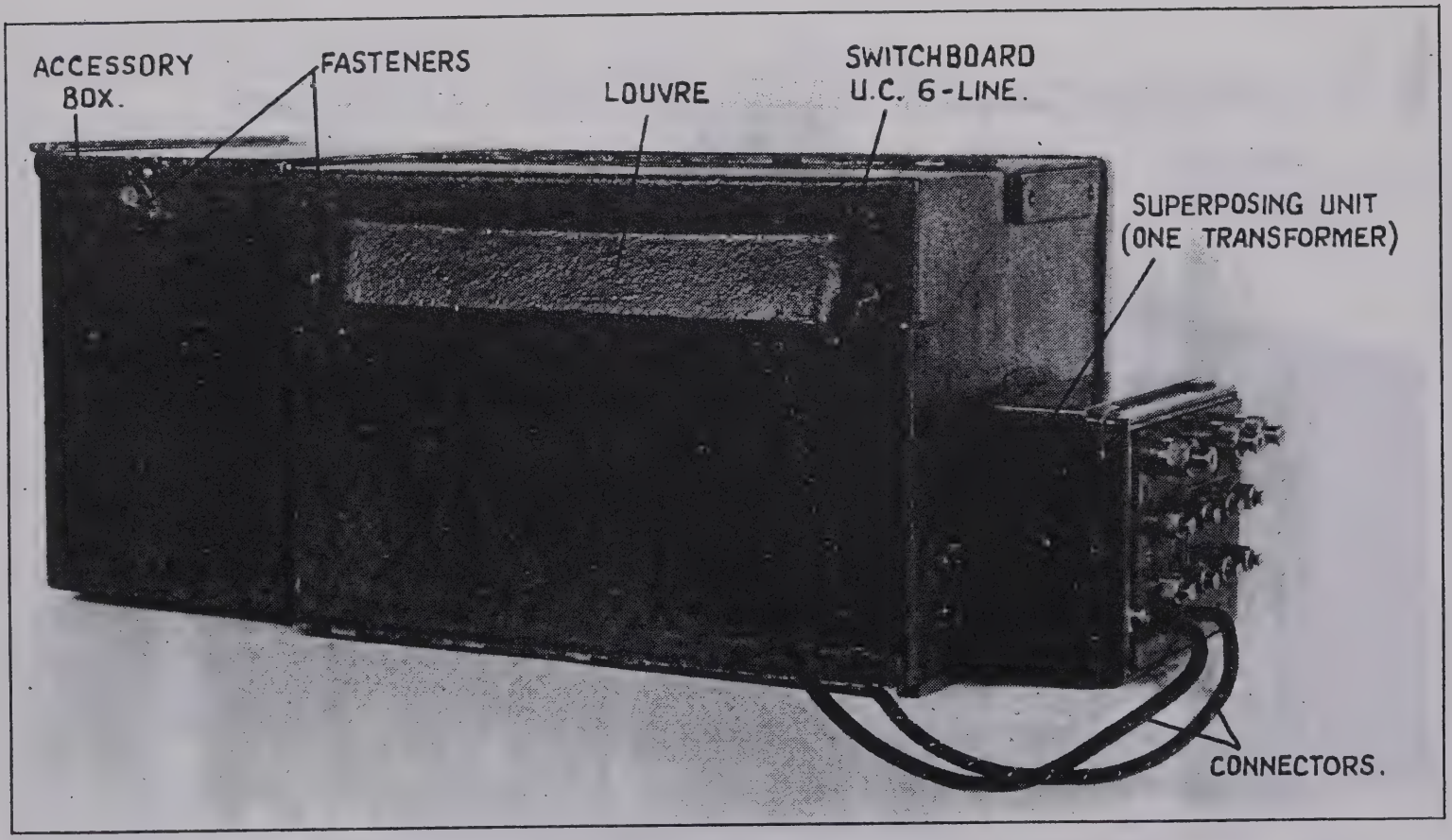


PLATE XIV

SWITCHBOARDS U.C. 6-LINE WITH SUPERPOSING UNITS (ONE TRANSFORMER) CONNECTED—REAR VIEW

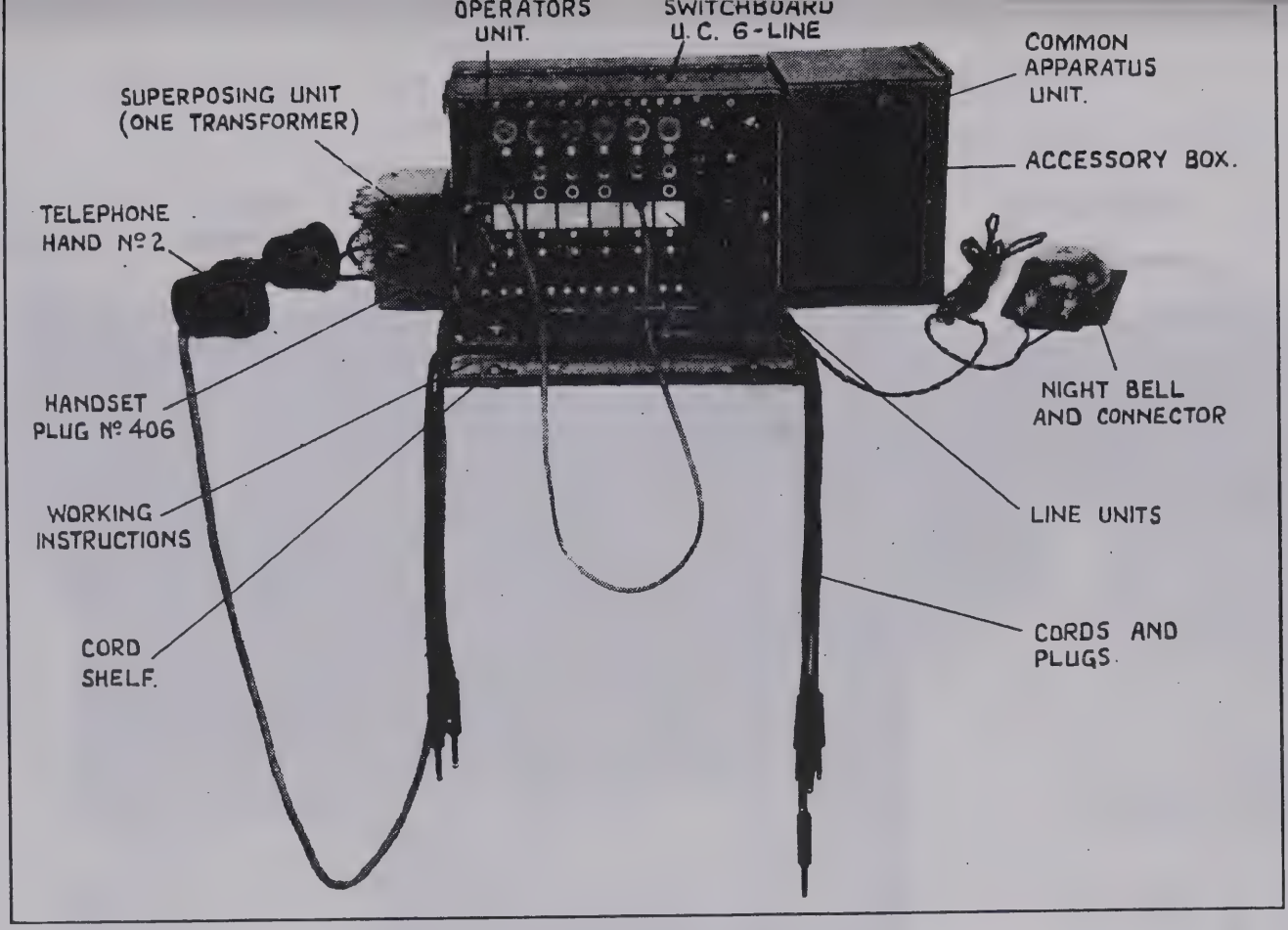


PLATE XV

SWITCHBOARDS U.C. 6-LINE WITH SUPERPOSING UNITS (ONE TRANSFORMER)—
FRONT VIEW, AS FOR WORK

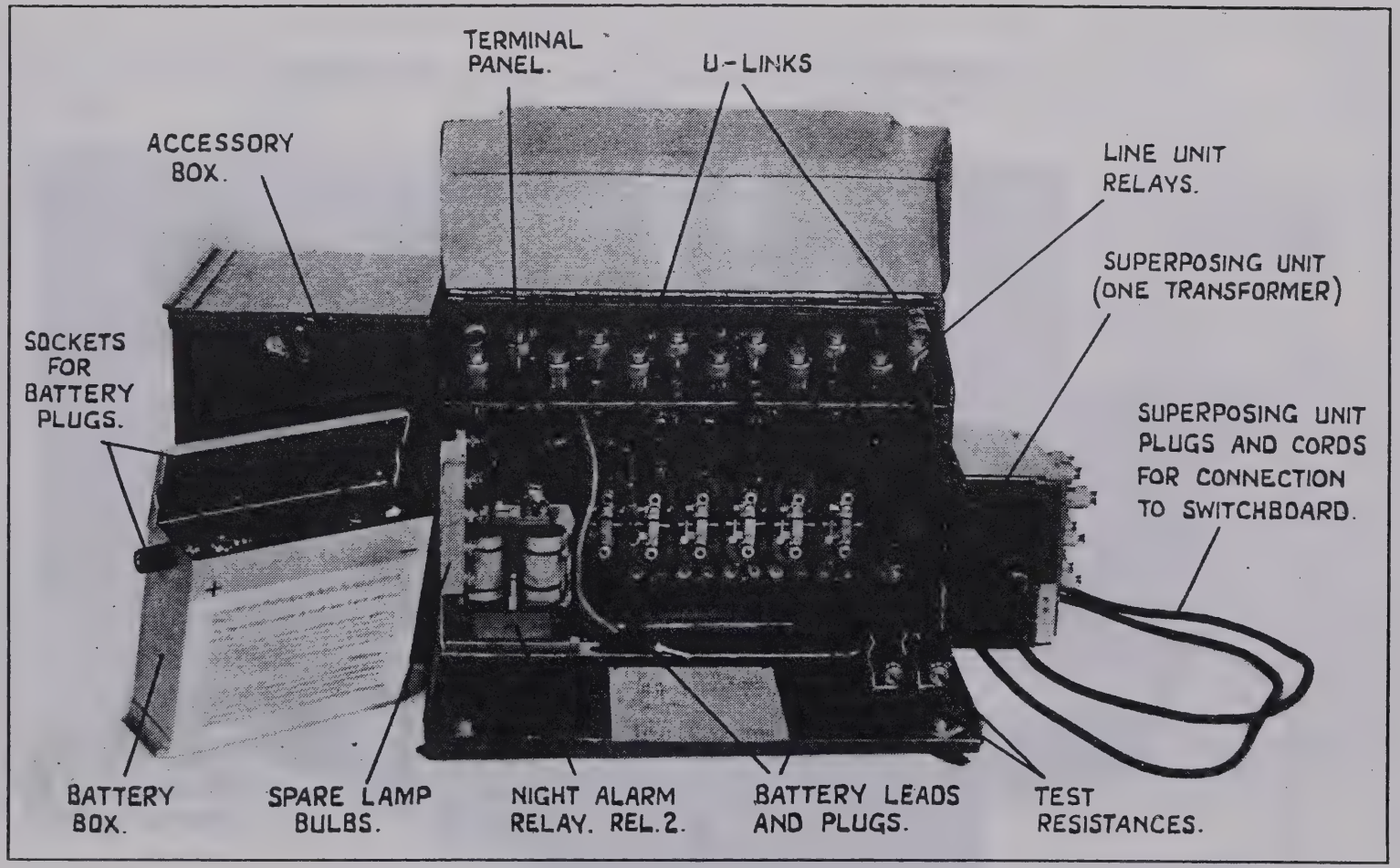


PLATE XVI

SWITCHBOARDS U.C. 6-LINE WITH SUPERPOSING UNITS (ONE TRANSFORMER)—REAR VIEW, OPEN, WITH BATTERY BOX REMOVED

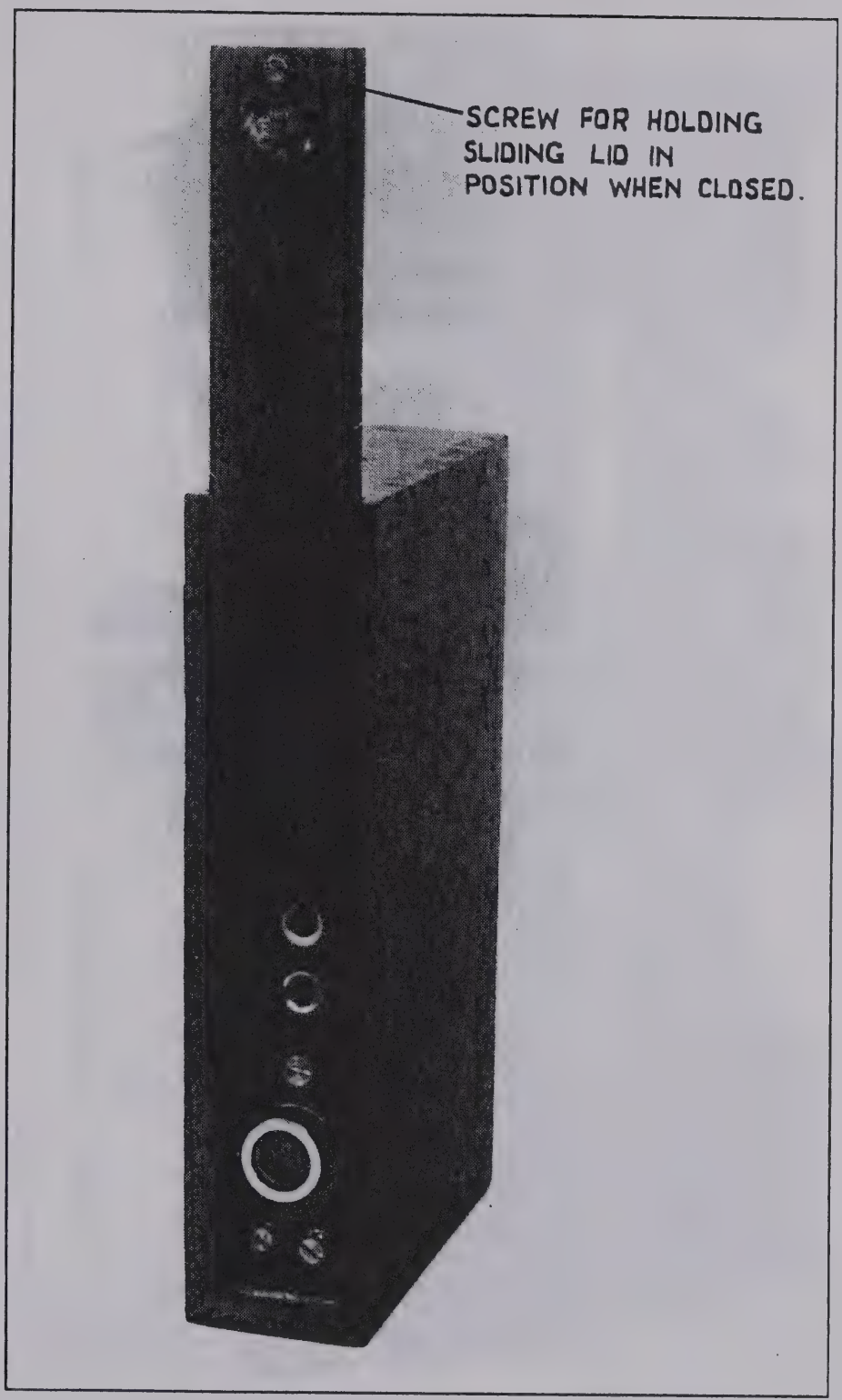


PLATE XVII

SPARE LINE UNIT IN BOX

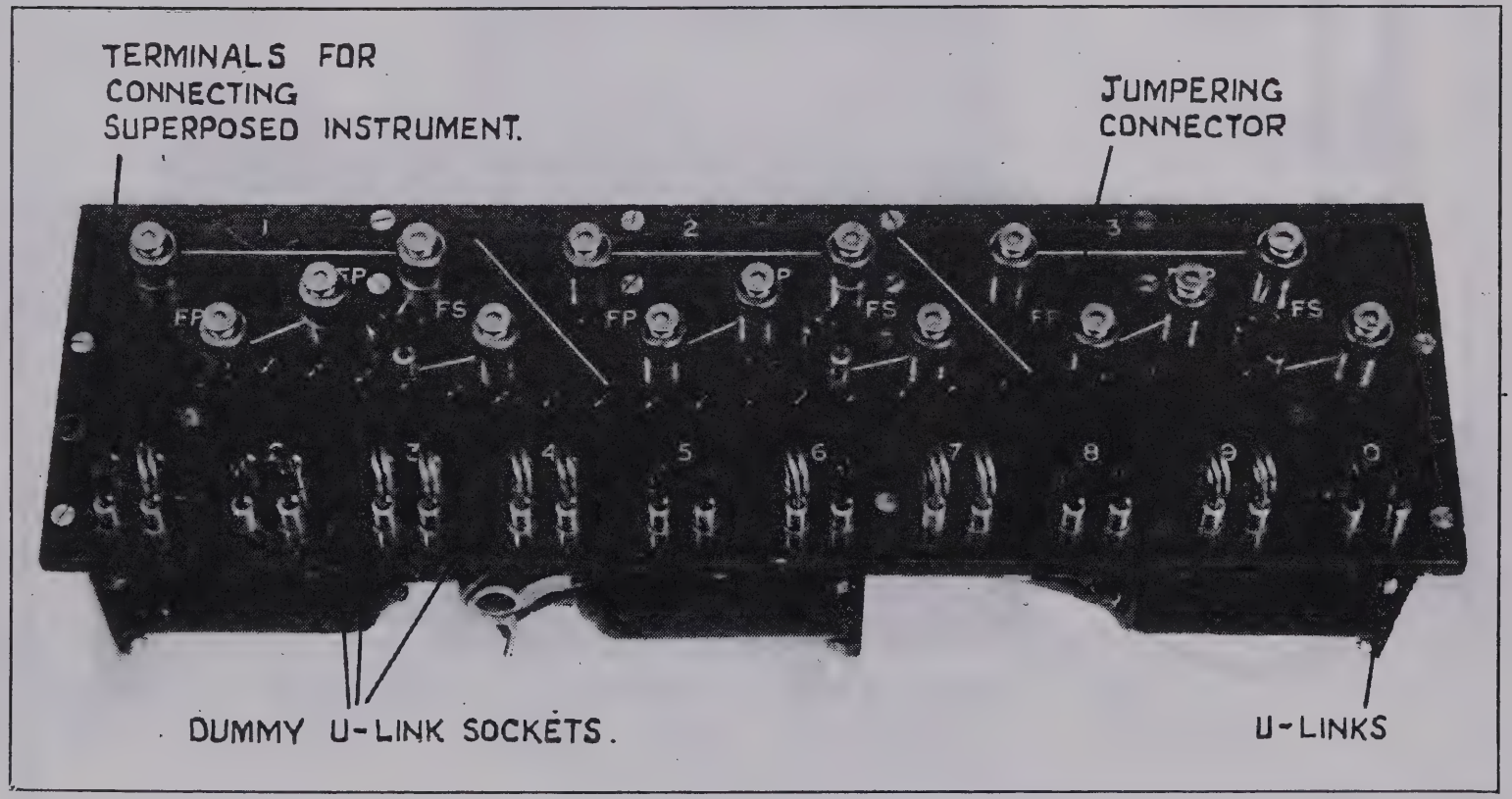


PLATE XVIII

SUPERPOSING UNITS (THREE TRANSFORMER)—VIEW OF TOP OF PANEL

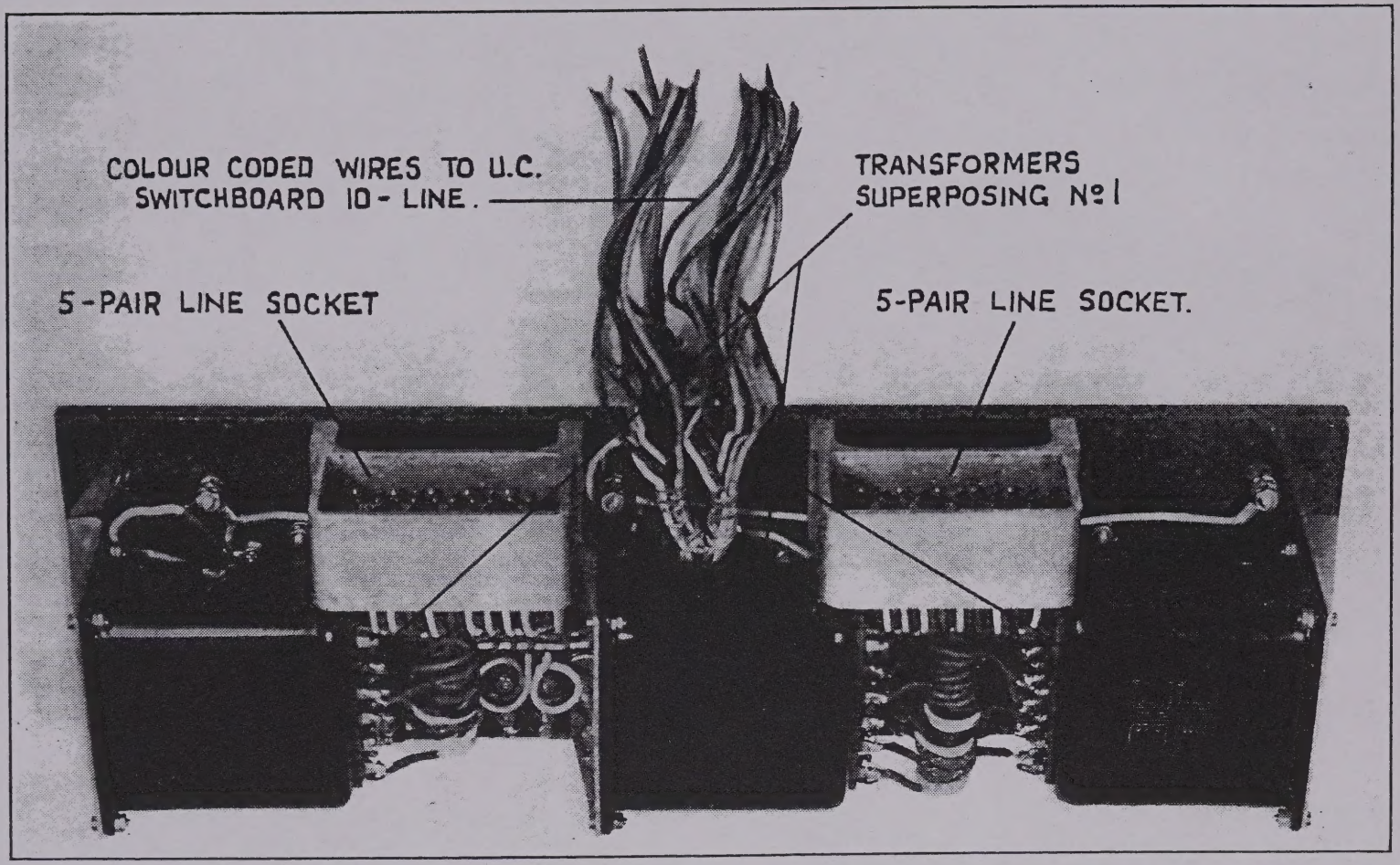


PLATE XIX

SUPERPOSING UNITS (THREE TRANSFORMER)—VIEW OF UNDERSIDE OF PANEL

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